A star (✱) indicates that the Abstract deals with Apparatus and Instruments.

FEBRUARY, 1940.

GENERAL PHYSICS.

ATOMIC AND MOLECULAR STRUCTURE.

289. Binding energy of H^3. F. W. BROWN. *Phys. Rev.*, **56,** *pp.* 1107–1110, *Dec.* 1, 1939.—A calculation has been made of the constants in the meson type of potential by fitting the scattering data for the scattering of slow neutrons by protons and the binding energies of H^2 and H^3. Assuming interaction between any 2 particles to be $(P_{ij}+gP_{ij}Q_{ij})$ $(Ce^{-\lambda r_{ij}}/r_{ij}\lambda)$ one gets $C = 49\cdot54\ mc^2$, $g = 0\cdot2667$, $\lambda = 1\cdot536\ (mc^2/e^2)$. This potential gives results which will be very little different from those given by the spherically symmetrical parts of the interaction obtained from meson field theory. The use of the co-ordinates introduced by James and Coolidge [see Abstract 2426 (1937)] allows sufficient simplification so that the results can be easily modified to take account of other types of spin dependence. The possibility of λ and C being different for different particle interactions may also be taken into account. AUTHOR.

290. Spin-orbit coupling in the α-model of light nuclei. D. R. INGLIS. *Phys. Rev.*, **56,** *pp.* 1175–1180, *Dec.* 15, 1939.—If light nuclei are approximated by the α-model, with the particles localized in clusters of 4 (or less), the particle with uncompensated spin is accelerated by the relatively weak attraction of α's, or by the difference of the attractions of two clusters. Then the Thomas relativistic term is not in general larger than the Larmor magnetic term in the spin-orbit coupling in contrast to the result of the central model, wherein the acceleration may be attributed to unsaturated forces toward one centre. The relative magnitudes of these terms are estimated for the α-model of Li^7 and C^{13}, two of the few nuclei to which it is here considered that the model might apply. The magnetic moment consistent with the Larmor-Thomas coupling in the α-model of B^{11} is found to be considerably larger than the experimental value. The quadrupole moment of the deuteron implies a spin-orbit coupling arising directly from angle-dependent nuclear forces. The appropriate "spin-orbit-spin" angle dependence suggested by the meson theory causes no first-order coupling in the α-model of Li^7, however, and a rough estimate of the second-order doublet splitting shows that it may be considerably smaller than that due to the Larmor and Thomas terms. AUTHOR.

291. Nuclear isomerism in zinc. J. W. KENNEDY, G. T. SEABORG AND E. SEGRÈ. *Phys. Rev.*, **56,** *pp.* 1095–1097, *Dec.* 1, 1939.—Zn^{69} has two isomeric states differing by 0·47 emV in energy. The upper state decays into the lower with a half-life of 13·8 hours, emitting a γ-ray which has an internal conversion coefficient less than 0·1. The lower isomeric state decays to Ga^{69} with a half-life of 57 min. The most probable value for the spin difference between the isomeric states is 5. AUTHORS.

292. Isotope separation. W. WALCHER. *Ergeb. d. exakt. Naturwiss.*, **18,** *pp.* 155–228, 1939.—The scope of this survey can be judged from the following list of major subdivisions of the subject matter: (I) Methods of determination of the abundance ratio of isotopes. (II) Methods of isotope separation ; electrolytic separation ; separation by diffusion ; separation by fractional distillation ; separation by chemical exchange reactions ; separation by thermo-diffusion ; centrifugal separation ; mass-spectrographic separation ; photochemical separation. (III) Comparison of the methods of separation now commonly in use. A bibliography of 191 references to original papers is appended. J. E. K.

293. Molecular structures of sulphuryl fluoride and thiophosphoryl fluoride. D. P. Stevenson and H. Russell. *Am. Chem. Soc., J,* **61,** *pp.* 3264–3268, *Dec.,* 1939.—The structures of sulphuryl fluoride and thiophosphoryl fluoride have been investigated by the electron diffraction technique. The interatomic distances and bond angles are : for sulphuryl fluoride, $S-F = 1{\cdot}56 \pm 0{\cdot}02$ Å, $S-O = 1{\cdot}43 \pm 0{\cdot}02$ Å., $\angle F-S-O = 105 \pm 2°$, and $\angle F-S-F = 100 \pm 10°$; and for thiophosphoryl fluoride, $P-F = 1{\cdot}51 \pm 0{\cdot}02$ Å, $P-S = 1{\cdot}85 \pm 0{\cdot}02$ Å, $\angle F-P-F = 99{\cdot}5 \pm 2°$, and $\angle F-P-S = 118 \pm 2°$. The relationship between the structures found and the resonating valence bond structures is briefly discussed. Authors.

294. Molecular structures of glyoxal and dimethylglyoxal. J. E. LuValle and V. Schomaker. *Am. Chem. Soc., J.,* **61,** *pp.* 3520–3525, *Dec.,* 1939.—The configurations of glyoxal and dimethylglyoxal as determined by the electron diffraction method are given by the following parameters :

Glyoxal : $C-H = 1{\cdot}09$ Å (assumed), $C=O = 1{\cdot}20 \pm 0{\cdot}01$ Å, $C-C = 1{\cdot}47 \pm 0{\cdot}02$ Å, angle $C-C=O = 123° \pm 2°$;

Dimethyglyoxal : $C-H = 1{\cdot}09$ Å (assumed), $C=O = 1{\cdot}20 \pm 0{\cdot}02$ Å, $C_2-C_3 = 1{\cdot}47 \pm 0{\cdot}02$ Å, $C_1-C_2 = 1{\cdot}54 \pm 0{\cdot}02$ Å, angle $CO-C=O = 123° \pm 2°$, angle $CH_3-C=O = 122{\cdot}5° \pm 1°$.

The electron diffraction data and the dipole moment data as well as chemical information indicate uniformly that both molecules are coplanar with the *trans* configuration and that rotation around the C—C bond connecting the adjacent carbonyl groups is restricted. Authors.

295. Lengths of links of unsaturated hydrocarbon molecules. C. A. Coulson. *J. Chem. Phys.,* **7,** *pp.* 1069–1071, *Dec.,* 1939.—The lengths of the links in conjugated chain molecules $C_{2n}H_{2n+2}$ and in condensed aromatic hydrocarbons such as benzene, naphthalene and diphenyl are calculated on the assumption that there is a simple interaction energy between all contiguous C—C bonds. The lengths thus deduced are in excellent agreement with those determined by the use of quantum-mechanical ideas of resonance. [See also Abstracts 887 and 3485 (1939).] Author.

296. Molecular state of inorganic liquids. A. R. Morgan and S. T. Bowden. *Faraday Soc., Trans.,* **36,** *pp.* 394–397, *Feb.,* 1940.—Molecular weight determinations on non-polar and dipolar inorganic chlorides in benzene solution indicate that the liquids behave as normal solutes with the exception of PCl_3 and $POCl_3$ which show slight deviations from ideality. The results are briefly discussed in the light of the various formulae for calculating association factors, and also from the standpoint of the exponential formula for the variation of viscosity with temperature. Authors.

297. Simple relationship between ionic refraction, ionic radius, and atomic numbers of the elements. E. Kordes. *Zeits. f. phys. Chem. Abt. B.,* **44,** 4, *pp.* 249–260, 1939.—Various simple relationships between atomic number, effective radius and refractivities of ions are discussed.

The ionic refractions calculated on the basis of the atomic numbers and Born's repulsion indices are in good agreement with values determined in various ways by other authors; and the ionic radii calculated from observed refractivities of free ions agree well with the accepted values. The Born repulsion indices valid for rare-gas configurations stand in a simple relationship with the principal quantum numbers of the rare gases.
C. B. A.

See also Abstracts 299, 449, 457, 459, 473, 495, 499, 526, 527, 538.

COLLOIDS.

298. Nuclear gold sols. Part II. Mechanism of formation. A. BAKER AND F. L. USHER. *Faraday Soc., Trans.*, **36**, *pp.* 385–392, *Feb.*, 1940.—The reduction of Au salts by PH_3 and by H_2S under certain conditions leads to the formation of nuclear Au sols. Under other conditions these reactions may give rise to sols of auric phosphide and auric sulphide, the properties of which are described. The reactions of Au salts with P in ether (Faraday's method), PH_3 and H_2S occur in at least two stages, one of which consists in the formation of an insoluble Au compound, and the last of which consists in a topochemical conversion of this into gold. It is suggested that the difference in the size of gold particles produced by nuclear and non-nuclear types of reducing agent is determined by the speed of the reaction which first produces an insoluble substance, rather than by the overall speed of the complete process. [For Part I see Abstract 4283 (1938).]
AUTHORS.

299. Molecular weight of sol and gel in crude rubber. A. R. KEMP AND H. PETERS. *J. Phys. Chem.*, **43**, *pp.* 1063–1082, *Nov.*, 1939.—The molecular weight of *n*-hexane soluble fractions of unmilled and masticated crepe have been determined from the viscosity and base-molal concentration by the Staudinger and Arrhenius equations. The molecular weight based on the Staudinger equation varies with concentration to a much greater extent than that obtained from the Arrhenius equation. High molecular rubber, as in crude rubber, was found to be unstable in tetralin. Milling results in oxidative breakdown of the macromolecules to a much smaller and uniform size. Hot milling yields a higher average molecular weight and a different distribution from cold milling. Ethyl alcohol and acetone (i.e. polar solvents) reduce the viscosity of rubber solutions in hexane and, added to hexane, peptize gel rubber.
J. B. W.

300. New investigations on phenoplastics. H. STÄGER, R. SÄNGER AND W. SIEGFRIED. *Helv. Phys. Acta*, **12**, 7, *pp.* 561–580, 1939. *In German.*—Extensive investigations as to their mechanical, chemical and dielectric properties confirmed that phenoplastics consist of a plastic mass of resin particles embedded in an elastic, macro-molecular framework. Through hardening the elastic component becomes preponderant. The structure, however, does not become regular, grindings showing it to be of the "elderpulp" type. Swelling causes shear-stresses, made visible by the occurrence of double refraction in the shearing planes. Moulded in plate-form and subjected to swelling the material breaks up into pieces of varying size, mainly dependent on the quantity of enclosures. Further conclusive evidence is obtained by purely mechanical tests. Transverse strength and angle of flexure are found to be functions of the time allowed for the hardening process. The results of impact tests were found to be influenced by the treatment undergone during the moulding of the samples. As to the dielectric properties, the usual way of representing them by the coefficient of surface leakage is inadequate, as a series of tests disclosed a number of secondary chemical effects. The electrolyte and its dissociation constant and concentration have much bearing on the development of the leakage path. A correct conception is gained by analyzing the dielectric losses. These result from the conductivity losses in the condensing mixture and the tendency of the phenolhydroxyl-group towards orientation within the molecule. By chemical adjustments the latter cause can be largely suppressed. Thereby the dielectric losses become almost independent of the frequency and very little dependent on temperature changes. H. O. S.

301. Behaviour of colloidal suspensions with electrolytes. E. A. Hauser and S. Hirshon. *J. Phys. Chem.*, **43**, *pp.* 1015–1036, *Nov.*, 1939. —Suitable mixtures of two sols of opposite sign can react producing gelation, etc., in a similar way to mixtures of sols and electrolytes. The viscosity characteristics of such a mixture of Fe_2O_3 and bentonite sols has been investigated by a MacMichael rotating cylinder viscometer, so determining the viscosity-time curves at a constant rate of shear. The curves for Fe_2O_3-bentonite sols and bentonite-$FeCl_3$ suspensions appear to be similar, so that the general mechanisms controlling the viscosity behaviour must be similar. A descriptive theory is put forward to account for the behaviour in terms of orientation, e.g. of bentonite particles about the oppositely charged iron oxide particles or about oppositely charged ions in the dispersion media, followed by condensation. The precise picture, which is given for various experimental data, depends upon the adsorption characteristics of the particles and ions involved and upon the ionic charges. J. B. W.

302. Streaming potentials and surface conductivity. Part III. E. Verlende. *K. Ned. Akad. Wet., Proc.*, **42**, 8, *pp.* 764–775, 1939. *In German.*—A new form of apparatus for the determination of streaming potentials is described. Measurements are described on solutions of KCl, for concentrations of 0 to 400 μmol./l, HCl 0 to 200 μmol./l, and $CaCl_2$ 0 to 100 μmol./l. The true value for the electrokinetic potential ζ and the specific surface conductivity σ_w are developed as functions of the concentration. On the assumption that the only force acting on the ions is developed from an electrostatic potential, the surface charge per cm^2. and the thickness of the diffuse layer are calculated as a function of the concentration. [See Abstract 4636 (1938) and 1876 (1939).] F. J. B.

303. Electrophoresis. *Ann. N.Y. Acad. Sci.*, **39**, *pp.* 105–212, *Nov.* 6, 1939.—A symposium comprising 7 papers.

" Introduction," by D. A. MacInnes (*pp.* 107–109).—A brief review of the subject of electrophoresis since the discovery by Reuss in 1808 of electro-osmosis. Of the vast amount of research carried out in the general field of electrokinetic phenomena, the most important has been due to Helmoltz, whose equations are still in use, while his discussions contain, to a greater extent than is generally realized, the beginnings of recent theories.

" Theory of electrophoretic migration." by H. Mueller (*pp.* 111–120). —The formulation of a rigorous theory is found to be hampered by the paucity of information about the molecular structure of surfaces and about the origin of interphasial potentials, and the author considers the dynamics of electrophoretic migration ; the electric double layer ; and the stability of hydrophobic colloids.

"Determination of electrical charge of surfaces by the microscopic method of electrophoresis," by H. A. **Abramson** (*pp.* 121–145).—The measurement of electrophoretic mobility of microsopic particles is first dealt with and begins with an historical review following which come sections on: Scope of the microscopic method; the flat cell in rectangular cross-section; calculation of potential gradient; effect of differences in sign of charge on particle and wall; rotating field; alternating field; rotating cell of cylindrical cross-section; double-tube cell; direct application of electrodes. The charge density is next considered in the sections: The effect of simple salts on the surface density of net charge of non-ionogenic surfaces; the effects of salts on the surface density of net charge on bacterial surfaces; the charge density of mammalian red blood cells; ion antagonism and the σ-c curve.

"Moving boundary method for studying electrophoresis," by K. G. **Stern** (*pp.* 147–186).—This very large subject is treated in the following chapters: Simple U-tube electrophoresis cells with quantitative electrophoretic studies by the light absorption method. Apparatus for analytical and for preparative purposes of H. Theorell, whose work is useful for the electrophoretic purification and isolation of biocolloids and of which very full details are included. Electrophoretic studies with the new apparatus and methods of Tiselius which are dealt with very comprehensively and with many diagrams. The results obtained by Tiselius and his collaborators are summarized as follows: The electrophoretic diagram of blood serum, which in the analytical ultracentrifuge shows only two to three different molecular species, now reveals the presence of four well-defined protein components one of which is serum albumin while the other three components are globulins.

"Observation of electrophoretic boundaries," by L. G. **Longsworth** (*pp.* 187–202).—In the electrophoresis of proteins by the Tiselius method, provision must be made for observing the progress of the migration and the following processes are discussed: The schlieren method; diffraction by the schlieren diaphragm; the scale method; and a comparison of the schlieren and scale methods.

"Characteristics of protein boundaries as shown by scale-method electrophoretic diagrams," by F. L. **Horsfall** (*pp.* 203–207).—The microcomparation of the position of scale lines, the plotting of scale line displacement graphs, and the integration of areas beneath the curves obtained are laborious and time consuming operations, but the accuracy of the method and the additional information gained well repay energy so expended. Scale-method electrophoretic diagrams may reveal minor degrees of boundary inhomogeneity which would be difficult to assess accurately by other methods, and permit the identification and calculation of mobilities for minor components which fail, even after maximum migration, to resolve into distinct boundaries separate from those of the major components. Finally scale-method diagrams make it possible to calculate the concentration of separate components even though the quantity of protein contained in them is relatively small, and with an accuracy comparable with micro-Kjeldahl analyses.

"Influence of ionic strength and *p*H on electrophoretic mobility," by B. D. **Davis and** E. J. **Cohn** (*pp.* 209–212).—Despite the great advances made by Tiselius and others, mobility is still determined in the presence of a relatively high concentration of other ions, generally of buffer ions, and the movement of the haemoglobin boundary is now studied under conditions for the determination of the relative importance of *p*H and ionic strength where the number and nature of the dissociating groups are known. At an ionic strength of 0·02 and a *p*H of 5·65 a mobility of $10 \cdot 3 \times 10^{-5}$ cm^2./volt.sec. was observed in phosphate buffers at 25° ; at the same *p*H this mobility was reduced to $2 \cdot 7 \times 10^{-5}$ at an ionic strength of 0·15. Change in ionic strength is thus of first importance. H. H. Ho.

304. The electrical double layer. *Faraday Soc., Trans.*, **36**, *pp.* 1–322, *Jan.*, 1940.—A general Discussion of the subject comprising 39 contributions.

" General Introduction," by E. K. Rideal (*pp.* 1–4).—Reviews very briefly the physical and biological significance of the double layer, stressing particularly the lack of precision in knowledge of the origin and structure of the layer.

PART I. EXPERIMENTAL METHODS AND RESULTS.

(A) Electrophoresis.

" Microscopic method of electrophoresis and its application to the study of ionogenic and non-ionogenic surfaces," by H. A. Abramson (*pp.* 5–15).—Reviews apparatus, experimental methods and results obtained since the publication of Ellis's pioneer work in 1912.

" Influence of electrolyte concentration on electrophoretic mobility of egg albumin," by A. Tiselius and H. Svensson (*pp.* 16–22).—The influence of salts upon the electrophoretic mobility and isoelectric point of egg albumin has been determined by the moving boundary method ; theories of the phenomena are advanced.

" Membrane potentials, valencies and theoretical and observed mobilities of haemoglobin and egg albumin," by G. S. Adair and M. E. Adair (*pp.* 23–32).—Membrane potentials, valencies and the excess of inorganic ions in the neighbourhood of a protein ion have been studied for comparison with measurements of the cataphoresis of dissolved proteins. Observed mobilities of haemoglobin ions agree with results calculated by using Henry's formula.

" Influence of electrolytes on electrophoretic mobility of serum albumin and haemocyanin," by P. Putzeys and P. Van de Walle (*pp.* 32–38).—The molecular dimensions of the proteins place them in the lower boundary of an intermediate region between the two extremes represented by the equations of Smoluchowski and Hückel for electrophoretic mobility ; the behaviours of serum albumin and haemocyanin in the presence of electrolytes are studied.

" Use of thin layers in electrophoretic separation," by J. St. L. Philpot (*pp.* 38–46).—A large scale electrophoretic separator, made of " Perspex," in which the substance to be separated flows in a thin layer between layers of dilute electrolyte, is described.

" Observations at the electrophoretic moving boundary with Lamm's scale method," by R. A. Kekwick (*pp.* 47–52).—A survey of the use of Lamm's method.

" Examination of electrokinetic charge density as a function of the thickness of the double layer," by A. J. Ham and E. D. M. Dean (*pp.* 52–57).—Measurements of the electrophoretic mobilities, potentials and charge densities of octadecane in the presence of the chlorides of Na, Ba and La at 25°C. at *p*H = 5 are recorded and discussed.

" Properties of detergent solutions. Part IX. Electrophoretic mobility of oil drops in detergent solutions," by J. Powney and L. J.

Wood (*pp.* 57–63).—A mean value of $4{\cdot}35\mu$ /sec./V./cm. at 25°C. is found for the electrophoretic mobility of "Nujol" dispersed in water; the influence of added alkalies and long-chain colloidal electrolytes is examined. [For Part X see following Abstract (*p.* 81).]

" Electrokinetics as a tool for study of molecular structure of organic compounds," by R. A. **Gortner** (*pp.* 63–68).—The electrokinetics of the aliphatic alcohols and acids, ethyl esters of the aliphatic acids, acetates of the aliphatic alcohols, 6 benzene derivatives and CCl_4 at a cellulose-organic liquid and an Al_2O_3-organic liquid interface have been studied.

(B) Streaming Potentials and Surface Conduction.

" Streaming Potentials and Surface Conductance," by A. J. **Rutgers** (*pp.* 69–80).—Results obtained with old and new forms of apparatus are surveyed; anomalous behaviour of the ζ-c curve for KCl solutions is attributed to surface conductance. The Helmholtz-Smoluchowski equation is derived and corrected.

" Electroviscous effect in egg albumin solutions," by H. B. **Bull** (*pp.* 80–84).—The viscosity of dilute solution of egg-albumin (conc. $<1\%$), at *p*H 1–11, has been studied at 35°C. Neither the Smoluchowski nor the Krasny-Ergen equation gives the correct order of magnitude for the electroviscous effect.

(C) Electrocapillarity and Other Methods.

" Electrochemistry of simple interphases, with special reference to that between mercury and solutions of electrolytes," by S. R. **Craxford** (*pp.* 85–101).—A general survey and discussion.

" Ionic concentration at interfaces," by G. S. **Hartley and** J. W. **Roe** (*pp.* 101–109).—The significance of ζ-potentials in determining ionic concentrations at interfaces is discussed in considerable detail.

PART II. THEORETICAL TREATMENT OF THE DOUBLE LAYER AND ITS IMPLICATIONS.

" Introductory Paper," by H. R. **Kruyt and** J. T. H. **Overbeek** (*pp.* 110–116).—A critical review of the mechanism of the double layer; a simple relation between electrophoretic mobility and colloid stability does not exist.

(A) Electrokinetic equations.

" Study of double layer at metal-solution interface by electrokinetic and electrochemical methods," by A. **Frumkin** (*pp.* 117–127).—A critical review, more especially of the properties of Pt and Hg electrodes.

" Observations on the double-layer capacity at Hg electrodes," by I. M. **Barclay and** J. A. V. **Butler** (*pp.* 128–133).—An oscillographic study of the negative polarisation of freshly made Hg surfaces shows the presence of 2 stages. There is no evidence that adsorbed H_2 is deposited at any potential below that at which H_2 is continuously evolved.

" Relaxation effects in the double layer. Cataphoresis; dielectric constant," by J. J. **Hermans** (*pp.* 133–139).—The theory of double-layer distortion for charged spherical particles moving in an external electric field is surveyed.

" The Helmholtz," by E. A. **Guggenheim** (*pp.* 139–144).—The measurement of the moment (τ) of an electrical double layer in volts shows confusion of thought. A suitable unit for τ is the Helmholtz, defined as 1 Debye/Å^2; the conversion of volts to Helmholtz is given by ζ volts = Dζ/12 Helmholtz, where D is the dielectric coefficient.

" Application of Debye-Hückel theory to disperse systems," by R. **Audubert** (*pp*. 144–153).—The Debye-Hückel theory in its classical form applies to disperse systems only when the ionic strength of the solution is very small; its extension to strong solutions necessitates the integration of additional terms other than the first of the Debye-Hückel equation and the consideration of surface processes such as selective adsorption and chemical reactions.

" Electrokinetic equations and surface conductance. Survey of diffuse double-layer theory of colloidal solutions," by J. J. **Bikerman** (*pp*. 154–160).—Electrokinetic equations, corrected to take account of surface conductance of capillary and colloidal systems, account for the maximum of ζ, the high dielectric constant of some sols, etc., and can be used to obtain definite values of ζ.

(B) Adsorption potentials.

" Adsorption potentials. Part I. General theory," by R. B. **Dean**, O. **Gatty and** E. K. **Rideal** (*pp*. 161–166).—Thin layers of insoluble substances, permeable to at least one ionic species can only affect diffusion potentials between 2 phases when they offer sufficient change in the resistance to passage of at least one ionic species. An expression for the diffusion potential through a thin permeable membrane is derived.

" Adsorption potentials. Part II. Oil-water potentials," by R. B. **Dean** (*pp*. 166–173).—A method for investigating the electrical properties of oil-water interfaces is described, and results supporting the conclusions of Part I (see above) are detailed.

" Adsorption potentials. Part III. Air water potentials," by R. B. **Dean and** O. **Gatty** (*pp*. 173–179).—The mechanism at air-monolayer-aqueous solution interfaces attracting ionized air particles is discussed.

(C) Colloid stability.

" Rôle of forces between particles in electro-deposition and other phenomena," by H. C. **Hamaker and** E. J. W. **Verwey** (*pp*. 180–185).—Electro-deposition is mainly a *mechanical* problem, the electric field merely moving the particles towards, and pressing them on to the electrode.

" Influence of particle size on physical behaviour of colloidal systems," by H. C. **Hamaker** (*pp*. 186–192).—The various forces concerned in the physical behaviour of colloidal systems and their dependence on particle size are discussed; the behaviour of colloidal systems under gravity and in a centrifuge is treated.

" Electrical double layer and stability of emulsions," by E. J. W. **Verwey** (*pp*. 192–203).—Discusses why a stable emulsion cannot be obtained without the presence of a special emulsifier.

" Repulsive forces between charged colloid particles, and theory of slow coagulation and stability of lyophobe sols," by B. **Derjaguin** (*pp*. 203–215).—A mathematical theory of the forces operative between particles and determining the stability of sols, suspensions and emulsions, with applications to thixotropy, etc., is developed. Agreement between theoretical and experimental determination of the force of repulsion between surfaces separated by liquid films is not satisfactory.

" Stability properties in hydrophobic sols: application of mutual energy of two particles," by S. **Levine and** G. P. **Dube** (*pp*. 215–229).—Applications of the expression, given by the authors, for the mutual energy of two colloidal hydrophobic spherical particles, are discussed.

" Significance of phenomenon of electrical charge in stability of hydrophobic dispersions," by H. Eilers and J. Korff (*pp.* 229–241).—Data on which are based the relation between the ζ-potential and the stability of lyophobic colloidal systems, are critically reviewed, and a more satisfactory, approximate relation is established between electric boundary phenomena and the stability of the system.

" Electrical double layer in relation to stabilization of emulsions with electrolytes," by D. F. Cheesman and A. King (*pp.* 241–247).—Generalizations, based on recent experimental work, relating to the stabilization of amyl alcohol/water emulsions with various electrolytes, are presented.

PART III. BIOLOGICAL AND TECHNICAL APPLICATIONS.

" Use of electrophoresis in the elucidation of biological problems," by L. S. Moyer (*pp.* 248–256).—A survey of recent work.

" Electrical double layer and virus stability," by A. S. McFarlane (*pp.* 257–264),—A survey of recent work.

" Consequences of electrical double layer in rubber technology," by D. F. Twiss, A. S. Carpenter and P. H. Amphlett (*pp.* 264–271).—The subject is reviewed generally and new work relating to the coagulation of dialyzed *Hevea* latex is presented.

" Anodic deposition of oleo-resinous lacquers," by C. G. Sumner (*pp.* 272–278).—A method of lacquering metal surfaces by electro-deposition from an oleo-resinous emulsion, developed primarily for the internal coating of tinplate cans, is outlined.

" Formation of deposit by electrophoresis," by H. C. Hamaker (*pp.* 279–287).—The production of coatings by electrophoresis from suspensions of $BaCO_3$, $BaSr(CO_3)_2$, $SrCO_3$, MgO, $MgCO_3$, Al_2O_3 and CaF_2 in methanol, ethanol, acetone or mixtures of these fluids is discussed.

" Deposition of oxide coatings by cataphoresis," by M. Benjamin and A. B. Osborn (*pp.* 287–295).—Experimental work concerned with the production of non-colloidal cataphoretic suspensions of the alkaline-earth carbonates and alumina, from which the particles may be deposited along with a cellulose binder is described.

" Wetting and flotation in connection with problem of transition layer." by P. Rehbinder (*pp.* 295–305).—A survey.

" ' Amphoteric ' double layer and the double ionic exchange in soils," by S. Mattson and L. Wiklander (*pp.* 306–319).—The simultaneous exchange of anions and cations at the equi-ionic point of soils occurs according to the mass law expressed by the Donnan equilibrium. The double ionic exchange leads to the conception of an " amphoteric " electrical double layer. J. S. G. T.

305. Properties of detergent solutions. Part X. Further observations on electrophoretic mobilities in detergent solutions. J. Powney and L. J. Wood. *Faraday Soc., Trans.*, **36**, *pp.* 420–426, *Feb.*, 1940.—Additional data concerning the electrophoretic mobility of oil drops in solutions of paraffin chain salts are recorded. The maximum mobilities in such solutions are obtained at concentrations which decrease with increasing chain-length. The abrupt changes of mobility which occur in the region of the concentration of the paraffin chain salt are discussed. The change of mobility with increasing temperature is dependent not only upon change of viscosity of the dispersion medium but also upon changes in the degree of adsorption of the long chain ions at the interfaces. The mobility of Nujol in sodium tetradecyl sulphate solutions of concentration greater than 0.33% is depressed by the addition of NaCl. At lower concentrations of the paraffin chain salt, however, the added electrolyte produces a considerable increase of mobility. Thus, on the addition of 0·02% Na Cl to 0·000 5% $C_{14}H_{29}SO_4Na$ at 60°C. the mobility rises from 8·3 to 14 μ/sec./V cm., a value only attained at 200 times this concentration in the absence of NaCl. The mobilities of ilmenite, calcium laurate and paraffin wax have also been determined and the results are discussed in connection with the influence of nature of particle on mobility. [For Part IX see preceding Abstract (*p.* 78).] AUTHORS.

306. Formation of periodic precipitates in presence of other precipitates. B. N. SEN. *Accad. Lincei, Atti,* **29,** *pp.* 488–490, *May* 6, 1939.—Referring to the formation of Liesegang rings of Prussian blue it has been found that when $CuSO_4$ reacts with $K_4Fe(CN)_6$ in presence of precipitated $CaSO_4$ or $BaSO_4$ the ferrocyanide of copper which is precipitated appears in the form of periodic streaks. In the present paper the characteristics of these streaks are studied in relation to the concentration of the reacting substances. It is not possible to give an exact explanation of the cause of these periodic precipitations, but it is probable that in this case the phenomenon is due to the selective absorption of some of the ionic species of the reacting system. Periodic spots were observed in the course of the experiments and in these spots partially formed rings. In some of the tests the concentrations of $CuSO_4$ were between 0·127 2 *M* and 0·014 1 *M*. In all the experiments $K_4Fe(CN)_6$ of 0·062 1 *M* was used. J. J. S.

***307. Simplest ultracentrifuge with photographic recording.** J. W. MCBAIN AND A. H. LEWIS. *Faraday Soc., Trans.,* **36,** *pp.* 381–384, *Feb.,* 1940.—Details of the construction and operation of the simplest air-driven ultracentrifuge are given, and it is shown that the results are practically as good as those hitherto attained with any of the standard ultracentrifuges. AUTHORS.

See also Abstracts 340, 360 and
45B. Effect of vulcanization on rubber structure. W. F. Busse.
46B. X-ray structure of vulcanized rubber. G. L. Clark.

CRYSTAL STRUCTURE AND SPECIAL PROPERTIES.

308. X-ray analysis and the structure of matter. W. H. BRAGG. *Roy. Soc., Proc. A.,* **173,** *pp.* 302–307, *Dec.* 18, 1939. *Nature,* **144,** *pp.* 961–963, *Dec.* 9, 1939. *Extract.*—The author gives a broad and critical review of the progress of knowledge of crystal structure since the development of X-ray analysis. Regarding a perfect crystal as unattainable in any large size, he discusses the effect of imperfections, even in apparently perfect crystals, results of the mosaic form in metals and salts, the X-ray as an investigating tool for organic and fibrous materials, connections between lattice structure and other physical properties, e.g. optical and magnetic, and chemical constitution. He pleads for investigation of Orowan's *structure sensitive* properties in relation to ordinary technical and industrial applications, e.g. of creep and conductivity, and points out the great advantage which the accuracy of the X-ray spectrometer confers on physicists concerned with the study of alloy systems. D. R. H.

309. Statistical thermodynamics of super-lattices. R. H. FOWLER AND E. A. GUGGENHEIM. *Roy. Soc., Proc. A.,* **174,** *pp.* 189–206, *Feb.* 1, 1940.—This paper establishes the precise statistical basis of Bethe's method of discussing order-disorder phenomena in super-lattices in Bethe's first approximation. It shows that for cubic lattices of the type here considered, in which all points of one super-lattice have as nearest neighbours points of the other super-lattice only, Bethe's first approximation is equivalent to the use of a method called the quasi-chemical method. The quasi-chemical method is an approximation which proceeds by assuming that the bond between any pair of nearest neighbours may be treated as if it were a chemical molecule, and the number of arrangements with given numbers of bonds as if the bonds did not interfere with each other. This method had previously been devised by one of the authors for the class of assemblies called *regular*, but it has not previously been applied to assemblies with long-range order. In the simple case considered, all the details of Bethe's method and the quasi-chemical method and the approximation on which they are based, and the relationship between them, can be made perfectly explicit. There seems reason to hope that the greater power of these explicit methods may enable them to be applied successfully for more complicated lattices, for which at present only the much rougher approximation of Bragg and Williams can be carried through. AUTHORS.

310. Structure of arsenates, molybdates and tungstates of NH_4, K and Tl. A. FERRARI AND O. NANNI. *Gazz. Chim. Ital.*, **69**, *pp.* 301–314, *May*, 1939.—The preparation of 11 compounds of type $(NH_4)_3AsO_4.12\,MoO_3.4H_2O$ is described. These show values of $a = 11{\cdot}60$–$11{\cdot}92$ Å, but the X-ray densities calculated do not check the observed values very well; the latter show considerable spread and the possibility is considered that this is due to partial loss of H_2O. It is shown that the H_2O in the large molecule is zeolitic in character—excluding the possibility of high poly-acids H_2O, $n$$MoO_3$, etc. These would require a solid lattice containing an envelope of MoO_3 molecules. X-ray data show the actual structure to be very near a b.c. lattice composed of two anions of type $AsO_4(MoO_3)_{12}^{---}$ in 0 0 0 and $\frac{1}{2}\,\frac{1}{2}\,\frac{1}{2}$, and six monovalent kations in $\frac{1}{2}\,\frac{1}{2}\,0\ \curvearrowleft$, and $\frac{1}{2}\,0\,0\ \curvearrowleft$ positions. D. R. H.

311. Structure of ferromagnetic ferric oxide, γ-Fe_2O_3. R. HAUL AND T. SCHOON. *Zeits. f. phys. Chem. Abt.B*, **44**, 3, *pp.* 216–226, 1939.—An examination is made, by X-ray and electron diffraction, of γ-Fe_2O_3 prepared from Fe_3O_4, from the Fe-arc and from $Fe(CO)_5$. No significant differences are found in intensity distribution or lattice constants in the three cases, but extra lines are observed in the diffraction spectra which must be attributed either to planes with mixed indices, thus implying a reduction in symmetry, or to the existence of a unit cell twice as large as that hitherto assigned to this substance. The possible space groups are discussed as far as they can be on the basis of the results obtained. J. T.

312. Graphite and graphite compounds. U. HOFMANN. *Ergeb. d. exakt. Naturwiss.*, **18**, *pp.* 229–256, 1939.—This paper comprises a survey of the crystal structure and chemical properties of graphite compounds. Separate sections are devoted to compounds of the alkali metals with graphite, graphite fluoride, graphite oxide and compounds of graphite with acids. The paper concludes with a list of 47 references to original researches. J. E. K.

313. Lamellar structure of potash-soda felspars. S. H. CHAO AND W. H. TAYLOR. *Roy. Soc., Proc. A.*, **174**, *pp.* 57–72, *Jan.* 12, 1940.—A previous general survey of orthoclase-microperthites suggested the existence of different types of lamellar structure according as the proportion of soda-felspar is less than or greater than 30% approximately. A new and more detailed examination confirms this, and suggests that the low-soda structure comprises monoclinic potash-felspar with triclinic soda-felspar lamellae in the mutual orientation characteristic of pericline twins, while the high-soda structure comprises monoclinic potash-felspar with triclinic soda-felspar lamellae oriented in accordance with the albite twin-law. The constitution of the soda-felspar, and the bearing of the new data on the general theory of microperthitic structures, are discussed. An examination of a Korean moonstone, apparently identical with material in which Ito claims to have established the existence of monoclinic soda-felspar [see Abstract 1456 (1939)] reveals a lamellar structure of the low-soda type described above. Ito's results are discussed. AUTHORS.

314. Structure of cyclohexane at –180°. K. LONSDALE AND H. SMITH. *Phil. Mag.*, **28,** *pp.* 614–616, *Dec.*, 1939.—At –180° cyclohexane is cubic with $a = 8{\cdot}41 \pm 0{\cdot}2$ Å, space group T_h^2 or 9_h^4, and 4 molecules in the unit cell. There is some indication that at a low temperature it displays a lower class of symmetry. C. A. S.

315. Interpretation of atomic distribution curves for liquids. C. A. COULSON AND G. S. RUSHBROOKE. *Phys. Rev.*, **56,** *pp.* 1216–1223, *Dec.* 15, 1939.—It is shown that if we approximate to a liquid by an Einstein model, in which each atom has a restricted region of motion, wherein it moves independently of its neighbours, and is surrounded by co-ordination shells of other atoms; and if we denote the density distribution of the atoms by $\rho(r)$, where r is the radial distance from any given atom; then the contribution to $\rho(r)$ made by any co-ordination shell, e.g. the ith, is a function $\rho_i(r)$ for which $r\rho_i(r)$ is symmetrical about its corresponding maximum value. The complete distribution curve, $r\rho(r)$ against r, is the sum of peaks of equal width and similar shape. A semi-empirical application of this theory to liquid Na, a reapplication of C. N. Wall's theory [see Abstract 515 (1939)], gives a latent heat of melting in fair agreement with experiment. The model suggests a change of structure on melting, since agreement with the experimental distribution curve is impossible if the number of atoms in the first co-ordination shell is that of solid Na. It is also shown that if the parameters in a partition function developed in this way are chosen to give agreement with any one physical property, then it is incorrect to add to the partition function terms representing "communal entropy." AUTHORS.

316. Intermolecular potential of mercury. J. H. HILDEBRAND, H. R. R. WAKEHAM AND R. N. BOYD. *J. Chem. Phys.*, **7,** *pp.* 1094–1096, *Dec.*, 1939.—The distribution function for liquid mercury from the melting point up to 250° recently published [see Abstract 4442 (1939)], has been used to calculate the intermolecular potential by aid of the equation derived by Hildebrand and Wood, $E = (2\pi N^2/v) \int \epsilon W r^2 dr$. This potential is accurately reproduced by the equation, $\epsilon = j/r^n - k/r^6$, with $j = 5{\cdot}49 \times 10^{-9}$ and $k = 3{\cdot}52 \times 10^{-10}$, for ϵ in dynes and r in angstroms. The attractive constant, k, checks exceedingly well with the value $3{\cdot}35 \times 10^{-10}$ calculated by the aid of the London formula for dispersion potential. Several other independent checks agree with the above potential function within the apparent limits of error of each. AUTHORS.

See also Abstracts 499, 528.

DENSITY.

317. Density, thermal expansion, vapour pressure and refractive index of styrene, and density and thermal expansion of polystyrene. W. PATNODE AND W. J. SCHEIBER. *Am. Chem. Soc., J.*, **61,** *pp.* 3449–3451, *Dec.*, 1939.—This paper includes the density, thermal expansion, vapour pressure, and refractive index of styrene, and the density and thermal expansion of polystyrene. A discussion of these latter properties is given in relation to other properties of the polymer. AUTHORS.

See also Abstracts 347, 489.

DIFFUSION AND OSMOSIS.

318. Anomalous diffusion of quinone in salt solutions. H. FREUNDLICH AND D. KRÜGER. *J. Phys. Chem.*, **43,** *pp.* 981–988, *Nov.*, 1939.—It has been shown that if salts (KCl, K_2SO_4, NaCl) diffuse in an aqueous solution of a second solute (quinone, succinic acid), the latter being uniformly distributed at first, the second substance changes its distribution where the concentration gradient of the salt is steep. If the solubility of the second solute is decreased by the salt (e.g. with quinone and K_2SO_4), there is a decrease in concentration of quinone on the salt side and an increase on the water side of the boundary. This was observed with quinone in solutions of KCl and K_2SO_4, and with succinic acid in solutions of NaCl and KCl. If the solubility of the second solute is increased by the salt (e.g. with quinone and KNO_3), the change in concentration is in the opposite sense. [See Abstract 3291 (1935).] A. J. M.

319. Study of diffusion processes by electrolysis with micro-electrodes. H. A. LAITINEN AND I. M. KOLTHOFF. *Am. Chem. Soc., J.*, **61,** *pp.* 3344–3349, *Dec.*, 1939.—Current-time curves with various shapes of electrodes and diffusion fields in the electro-oxidation of ferrocyanide ions were determined, and the condition under which theoretical diffusion conditions can be obtained are discussed. Theoretical conditions were not obtained with spherically symmetrical diffusion in aqueous solution, but were approached in 3% agar and 4% gelatin gels. With linear diffusion in such a direction as to produce a density gradient in the downward direction, the quantity $i\sqrt{t}$ was found to be constant to $\pm 0{\cdot}5\%$ over a period of 20 min. The temperature coefficient of the quantity $i\sqrt{t}$ was found to be in agreement with the calculated value. AUTHORS.

320. Streaming in diffusion fields. G. YOUNG. *Math. Biophysics, Bull.*, **1,** *pp.* 177–184, *Dec.*, 1939.—Two simple systems are discussed in which diffusion of a dissolved substance causes continued circulation of the solvent, through the mediation of gravitational forces in one case, and of solute viscosity forces in the other. The former is analogous to the circulation in a liquid heated from below. AUTHOR.

321. Molecular fields of CO_2 and N_2O. R. E. BASTICK, H. R. HEATH AND T. L. IBBS. *Roy. Soc., Proc. A*, **173,** *pp.* 543–554, *Dec.* 29, 1939.—Measurements of thermal diffusion in mixtures containing N_2O have been made between room temperature and about 300°C., which show that there is a sharp change in the nature of the molecular field of this gas at about 120°C. This conclusion is supported by viscosity measurements. Further thermal diffusion experiments have been made on CO_2 which support the authors' previous conclusion that there is a similar anomaly in the field at about 145°C. AUTHORS.

See also Abstract

23B. Diffusion of oxygen in copper. C. E. Ransley.

ELASTICITY AND PLASTICITY.

322. Increase of torsional stiffness of a prismatical bar due to axial tension. M. A. BIOT. *J. of Applied Physics*, **10,** *pp.* 860–864, *Dec.*, 1939.—The author's theory of elasticity of the second order is applied to calculate the increase of torsional stiffness of a prismatical bar when an axial tension is initially imposed upon it. It is found that the classical shear stress distribution is not affected by the axial stress. However, an increase of torsional stiffness is produced due to the fact that the boundary condition over the cross-section contains not only the shearing stress but also the product of the axial stress by the rotations. This increase of torsional stiffness turns out to be proportional to the polar moment of inertia of the cross-section with respect to its centre of gravity. AUTHOR.

323. Elastic moduli of ferromagnetic materials. Part I. Iron crystals. R. KIMURA. *Phys. Math. Soc. Japan, Proc.*, **21**, *pp.* 686–706, *Nov.*, 1939.—The Young's modulus and the rigidity modulus of iron single crystals of various orientations were determined by a dynamical method: the longitudinal or the torsional vibration of the specimen rod was excited magnetically by making use of Joule's or Wiedemann's magnetostrictive deformation, and the coincidence of the frequency of the exciting current with the natural frequency of the rod was detected by the change in the impedance of the coil wound around the specimen rod. From the values of these elastic moduli, the Voigt's moduli were evaluated. The corrections to be applied (due to (1) coupling of the torsional and the bending deformations, (2) the thickness of the specimen rod, (3) the external magnetic field and (4) the adiabatic nature of the experimental process) are discussed in detail. The final values obtained were: $S_{11} = 0{\cdot}768 \times 10^{-12}$, $S_{12} = -0{\cdot}270 \times 10^{12}$ and $S_{44} = 0{\cdot}896 \times 10^{-12}$. In an Appendix, the results of the statistical measurements are shown for the purpose of comparison. AUTHOR.

324. Transverse vibrations of curved membranes. C. E. WEATHERBURN. *Phil. Mag.*, **28**, *pp.* 632–634, *Dec.*, 1939.—The differential equation for the vibration of a curved membrane is found on the assumption that both in equilibrium and in the vibrating state the tension across a line element is normal to this element. The case is considered in which there is no external force, and that in which the external force is normal to the membrane. R. P.

See also Abstracts 300, 340, 507.

HYDRODYNAMICS AND AERODYNAMICS.

325. Vortices in a sheet of viscous liquid. G. PERETTI. *Accad. Lincei, Atti*, **29**, *pp.* 581–584, *June* 2, 1939.—Stationary movement of a sheet of viscous liquid results in a superficial viscous vortex. The motion is completely investigated. The resultant is zero, and, if the surface is plane, the moment reduces to that of the couple acting upon the vortex. W. A. R.

326. Heavy body rotating in liquid. G. GIRAUD. *Comptes Rendus*, **209**, *pp.* 620–623, *Oct.* 23, 1939.—In certain cases a heavy body, consisting of a solid core surrounded by a mass of liquid, rotating unformly about axes, is in stable equilibrium. [See following Abstract.] W. A. R.

327. Heavy body rotating in liquid. G. GIRAUD. *Comptes Rendus*, **209**, *pp.* 661–663, *Nov.* 6, 1939.—The small movements of a heavy body immersed in a liquid, in which each particle executes simple harmonic motion of period $2\pi/\lambda$ about the position of equilibrium, are investigated. [See preceding Abstract.] **Erratum,** *ibid.*, *p.* 812, *Nov.* 27, 1939. A. J. M.

See also Abstracts 344, 345, 361, 366.

KINETIC THEORY OF MATTER.

See Abstracts 321, 336, 520 and

36B. Mean free path in gases contained in a vessel. M. Saito.

MATHEMATICAL METHODS AND THEORY OF MEASUREMENTS.

328. Time distribution of so-called random events. A. Ruark. *Phys. Rev.*, **56,** *pp.* 1165–1167, *Dec.* 1, 1939.—It is shown that in a sequence of random events, the expected distribution of interval-sizes in a run of given duration differs from the Bateman distribution when the counting rate is different from the average one. The formula for "local" size-distribution to be expected for such a run is derived by the use of Bayes' theorem. It is pointed out that this theorem is useful in discussing the properties of any statistical system which is known to be in a condition differing from the idealized equilibrium state. Author.

329. Hystero-differential equation in a probability problem. L. Silberstein. *Phil. Mag.*, **29,** *pp.* 75–84, *Jan.*, 1940.—Consideration of the probability problem arising in the quantum theory of the photographic reciprocity failure leads to a so-called hystero-differential equation. This type of differential equation consists of a relation between the derivatives $f'(t), f''(t), \ldots$ etc., of the unknown function at the instant t and the value of the function $f(t - \tau)$ at some other, e.g. past instant, where τ is a fixed finite interval. The simplest form of the hystero-differential equation, $f'(y) = f(y - \eta)$, $y \gg \eta$, $c\tau = \eta$, is solved and discussed at length. Further in order to illustrate the subject in general and derive some interesting properties of the roots of the equation the case $\eta = 1$ is discussed in detail. S. W.

***330. Mechanical harmonic synthesizer-analyser.** S. L. Brown. *Frank. Inst., J.*, **228,** *pp.* 675–694, *Dec.*, 1939.—A harmonic synthesizer is described that has 30 harmonic elements (15 sine components and 15 cosine components) that operate simultaneously, and the sum of the 30 sinusoidal movements is recorded by a tracing point (pencil) on a drawing board that is driven uniformly past the pencil point. Analysis is accomplished by setting the amplitudes of the 30 elements to values that are determined from the values of selected ordinates from the curve to be analysed, and the harmonic components of this curve are determined from selected ordinates of the auxiliary curve that is traced by the machine. 32 equispaced ordinates from the curve to be analysed furnish sufficient data whereby analysis is accomplished, by a single trace of the machine, that includes 15 harmonic components (15 sine components and 15 cosine components); or, 64 equispaced ordinates may be taken from the curve and the analysis will include 31 harmonic components that are obtained from 2 traces made by the machine (odd harmonics are determined from one auxiliary curve and even harmonics from the other curve); or, 120 ordinates may be selected from the curve and the analysis is extended to 59 harmonic components by tracing 4 auxiliary curves with the machine. Author.

***331. Property of spherical mirror applicable to measurement of solid angles.** A. Bloch. *Journ. Sci. Instruments*, **17,** *pp.* 17–19, *Jan.*, 1940.—It is shown that an image seen in a small spherical mirror—however distorted it may be—has an apparent size (the solid angle subtended at the observer's eye), which is a fixed fraction of the solid angle subtended by the object at the mirror. This fraction depends only on the distance observer-mirror and on the radius of the mirror. The property is applicable to the measurement of solid angles, as the solid angle subtended by such images at the observer's eye can be determined with sufficient accuracy from the plane area covered by their photographs or their perspective projection. AUTHOR.

See also Abstracts **335**, **365**, **511**, **538**.

MECHANICS, CLASSICAL.

332. Impulsive motion of non-holonomic systems. G. ARRIGHI. *Accad. Lincei, Atti*, **29**, *pp.* 472–477, *May* 6, 1939.—The standard equations for non-holonomic systems are generalized in such a manner as to be applicable to cases of impulsive motion. R. P.

333. Equimomental and orthoconjugate complex of a force-system. H. BAGCHI. *Calcutta Math. Soc., Bull.*, **31**, *pp.* 81–86, *June*, 1939.—A paper dealing with the quadratic complex, formed by the ∞^3 of lines round any of which the resultant moment of a given system of forces acting on a rigid body has a pre-assigned positive value. It is shown that the orthoconjugate complex of a force-system is identical with the quadratic complex made up of the axes of the principal moment. [See Abstract 1926 (1939).] S. A. S.

See also Abstract **339**.

MECHANICS, QUANTUM.

334. Propagation of wave packets. G. BADARAU. *Comptes Rendus*, **209**, *pp.* 551–554, *Oct.* 9, 1939.—The motion of a wave group in a field of force is studied and it is shown that the phase of the wave shows terms which correspond to the curvature of the path. R. P.

335. Integration of de Donder's equation and determination of the monochromatic wave. G. BIBEN. *Comptes Rendus*, **209**, *pp.* 726–728, *Nov.* 13, 1939.—De Donder's equation [see Abstract 3145 (1939)] is solved for the case of a monochromatic spherical wave in the Schwarzschild field. G. C. McV.

336. Effusion phenomena in relativistic quantum statistics. D. V. GOGATE. *Phil. Mag.*, **29**, *pp.* 85–92, *Jan.*, 1940.—This paper deals with the phenomenon of the effusion of energy of an ideal gas through a narrow orifice taking account of relativistic quantum statistics. In section (1) non-degenerate matter is considered and the amount of energy effusing per unit area is calculated. In section (2) the effusion of energy is calculated for a completely degenerate gas, degenerate in the sense of Fermi-Dirac statistics. It is also shown that, in the case of complete degeneracy, the same expression holds for the rate of effusion of mass throughout the whole region from completely non-relativistic to completely relativistic. The results are displayed graphically in section (3) to bring out clearly the physical significance of the different formulae for the various cases of non-degeneracy and degeneracy. [See Abstract 3962 (1938).] AUTHOR.

See also Abstracts **365**, **438**, **500**, **538**, **539**, **540**.

PHILOSOPHY OF SCIENTIFIC METHOD.

See Abstract **342**.

PRESSURE.

***337. Automatic Pirani vacuum gauge.** E. J. SCOTT. *Rev. Sci. Instruments*, **10**, *pp.* 349–350, *Nov.*, 1939.—Describes an instrument consisting essentially of a Pirani gauge and a vacuum-tube ohmmeter and which indicates the pressure automatically on a calibrated galvanometer scale. Since the resistance of a fine wire in a partially evacuated system is a function of the pressure, the measurement of this resistance is therefore a measure of the pressure. In the present instrument the resistance is measured by feeding the voltage drop across it onto the grid of a triode tube. As the resistance varies in accordance with changes in the pressure of the gas, the voltage-drop across the resistance, and hence on the grid of the tube, will also vary. This allows the pressure to be read directly on the calibrated scale of a galvanometer contained in the plate circuit. S. A. S.

***388. Piezoelectric versus mechanical spring pressure gauge.** R. A. Webster. *J. of Applied Physics*, **10**, *pp*. 890–891, *Dec.*, 1939.—That difficulties in the use of various types of pressure gauges warrant meticulous scrutiny in the rendering of an accurate pressure-time curve has advanced each type of gauge for particular work. In powder gas and internal combustion engine gas pressures the spring type and piezoelectric type offer great possibilities with the first a self-contained unit and the latter a charge-collecting device, and with the former following the true curve by an admitted time lag and the latter assumed to be responding instantaneously. Sparse comparative records of the two show the case to be more nearly the reverse of what the popular assumption leads one to believe. Fuller data are needed to determine the comparative lagging characteristics of both types. Author.

***389. Measurement of pressure, movement, acceleration, etc., by electrostatic systems.** C. H. W. Brookes-Smith and J. A. Colls. *Journ. Sci. Instruments*, **16**, *pp*. 361–366, *Dec.*, 1939.—As pick-up element serves a small condenser, one plate being a diaphragm integral with the tubular element body. By careful design a linear characteristic and elimination of falsifying effects are achieved. Adaptors provide for protection, convenient adjustment, and adaptation to various measurements such as indicated in title. For translating the capacity changes into potential variations, recorded by the oscillograph, a d.c. polarization circuit can be employed. Dependency on time constant, however, excludes application to slow processes. Using a h.f. resonance circuit, carrier frequency about I Mc./s., the capacity changes can be balanced by a calibrated condenser. This null method, independent of circuit constants, renders static calibration possible. Useful range from zero to 50 kc./s. Tested at 400°C. and 300% overload, elements for pressures up to 6000 lb./in^2. showed a change in calibration of less than 1% full scale. Mechanical pressures up to $\frac{1}{2}$ ton could be recorded by standard-type elements, loads up to 100 tons by one of special design. Small movements of 0·000 01 in. and less, and accelerations from $+20g$ to $-10g$ were conveniently measured. H. O. S.

***340. Recent American advances in physical apparatus and technique.** C. J. Overbeck. *Journ. Sci. Instruments*, **17**, *pp*. 1–17, *Jan.*, 1940.

***341. Accurate direct-reading manometer for corrosive and other gases.** R. Spence. *Faraday Soc., Trans.*, **36**, *pp*. 417–419, *Feb.*, 1940.—A glass manometer is described in which the relation between scale reading and pressure is linear. The dead space is small and practically constant (variation 1·25% for 1 atm.) and pressures up to 1 atm. can be readily determined to within 0·25 mm. Hg. The instrument is specially suited for the study of gas reactions. Author.

RELATIVITY AND ETHER.

342. The relativity of time. H. Dingle. *Nature*, **144**, *pp*. 888–890, *Nov.* 25, 1939.—According to the restricted theory of relativity, moving measuring rods are shortened in the direction of motion, and moving clocks run slow in the rates $(1-v^2/c^2)^{\frac{1}{2}} : 1$; this view is correct so far as measuring rods are concerned but is incorrect with respect to clocks. Circumstantial evidence for the contraction of a moving rod is given by the Michelson-Morley and other experiments ; there is no evidence for the definite retardation of clocks. There is, in physics, no explicit definition of a clock. By consideration of a clock of hour-glass type it is shown that the ratio of time intervals recorded by stationary and moving clocks is different according as the interval is measured by the *number*, by the total weight or by the total volume of similar particles falling into a receptable. The corrections to be applied to the readings of clocks in motion in order to realize the readings of an ideal clock if it were set moving are almost as various as the constructions themselves. The transformation formula for t is a logical consequence of that for x ; it is the necessary consequence if Newtonian mechanics is to hold good for uniformly moving systems despite the change of x. The Kennedy-Thorndike experiment does not afford a confirmation of the Lorentz transformation for time, but shows that light behaves as an ideal clock. The statement that relativity has caused a fusion of time and space is not true ; the conformability of light to Newtonian mechanics, established by the Michelson-Morley and Kennedy-Thorndike experiments, makes it possible to define corresponding units of space and time in terms of light. J. S. G. T.

343. Isotropic manifolds in the theory of relativity. D. N. MOGHE. *Indian Acad. Sci., Proc. Sect. A*, **10,** *pp.* 275–278, *Oct.*, 1939.—A Riemannian manifold V_n is such that it is isotropic about the geodesics normal to a V_{n-1}. If the curvature is constant and the V_{n-1} is itself isotropic, the metric of the V_n can be determined uniquely provided every V_{n-1} is conformal to every other along the geodesics to which the V_{n-1} are normal. When the V_n is isotropic about a point the contracted Riemannian tensor is proportional to the fundamental tensor. G. C. McV.

344. Stability of equilibrium of an isolated fluid sphere. D. N., MOGHE. *Indian Acad. Sci., Proc. Sect. A.*, **10,** *pp.* 399–406, *Nov.*, 1939.—The equations of the geodesics define the motion of a particle in a gravitational field and for this motion to be stable it is necessary that $\{44, \alpha\} = 0$ $(\alpha = 1, 2, 3)$ where the suffix 4 denotes the time and 1, 2, 3, the space co-ordinates. This criterion is applied to Tolman's line-elements for the interiors of static fluid spheres, the equilibrium of which is shown to be partially stable only. The corresponding non-static cases already discussed [see following Abstract] are also found to be in partial equilibrium. Consideration, however, of the distortion in the line-element due to the breakdown of equilibrium shows that surfaces of stability exist for fluid spheres. G. C. McV.

345. Non-static solutions of Einstein's gravitational equations and fluid spheres with pressure and density as slowly varying functions of time. D. N. MOGHE. *Indian Acad. Sci., Proc. Sect. A*, **10,** *pp.* 407–416, *Nov.*, 1939.—The restrictions on the general spherically symmetric non-static line-element imposed by the assumptions that matter is isotropic and at rest are considered. The form of the line-element for a sphere of perfect fluid having a boundary at which the hydrostatic pressure vanishes is found and four possible cases are discussed. The line-elements for the regions outside such spheres are also briefly discussed. [See preceding Abstract.] G. C. McV.

346. Alternative explanation of relativity phenomena. A. Eagle. *Phil. Mag.*, **28,** *pp.* 694–701, *Dec.*, 1939.—An alternative explanation of the three crucial phenomena of Einstein's general theory of relativity is presented. The deflection of light passing near the sun is deduced by assuming that the change of velocity of light in a gravitational field is proportional to the potential of the field. The shift of spectrum lines is accounted for by assuming that both K and μ increase in the same definite ratio in a gravitational field ; it is suggested that the actual shift is double Einstein's value. Rotation of the apse line of Mercury's orbit is accounted for by assuming that the constant of gravitation at any point varies as V^λ, where V is the velocity of light at that point ; λ is found to have the value 2. J. S. G. T.

See also Abstracts 335, 478.

SOLUTION.

347. Solubility, viscosity and density of KI–I mixtures. G. Venturello and N. Agliardi. *Gazz. Chim. Ital.*, **69,** *pp.* 333–339, *May*, 1939.—From measurements of Δ and η for solutions of (KI + I) in water, the authors deduce the existence of the molecules KI_3, KI_7, KI_9. D. R. H.

348. Solubilities of salts in dioxane-water solvents. T. W. Davis and J. E. Ricci with C. G. Sauter. *Am. Chem. Soc., J.*, **61,** *pp.* 3274–3284, *Dec.*, 1939.—The solubilities of silver acetate, silver sulphate and barium iodate have been determined at 25° in a series of dioxane-water solutions extending from 0 to 100% dioxane. The dielectric constants cover the range 2·1 to 78·55. The solvent effect of potassium nitrate, barium nitrate, magnesium chloride and potassium bromate solutions on barium iodate in water has been examined experimentally. The solvent effects of potassium nitrate, sodium nitrate and potassium chlorate on silver acetate in 10% dioxane solutions, and of potassium chlorate on silver acetate in 20% dioxane, have also been investigated. The corresponding Debye-Hückel *a* parameters have been calculated. The Born equation even when corrected for interionic effects fails to account for the course of the solubilities as the percentage of dioxane increases, predicting in each case lower solubilities than those observed. The differences increase in media of higher dioxane content, prediction and observation disagreeing even as to order of magnitude in solvents containing more than 50% dioxane by weight. The disagreement is not diminished appreciably by substitution of mole fractions for volume concentrations, showing that this question is of minor importance as a factor in the application of the Born equation. Modifications to be superimposed on the Born equation to bring it into line with the observations are discussed. Authors.

349. Solubilities of Na and K salts of nitrophenols and related acids. O. C. Dermer and V. H. Dermer. *Am. Chem. Soc., J.*, **61,** *pp.* 3302–3303, *Dec.*, 1939.—The sodium and potassium salts of 10 possible potassium precipitants, mostly nitrophenols, have been synthesized and their solubilities at 30° determined. The most sensitive reagents in the group were dipicrylamine and dilituric acid. Introduction of additional groups into the molecules of such potassium reagents as picric acid, dilituric acid, and 2-chloro-3-nitrotoluene-5-sulphonic acid is more likely to decrease than to increase their value. Authors.

SURFACE PROPERTIES.

350. Adsorption of H_2 by Cu dispersed in CaO. J. R. LEWIS, L. J. E. HOFER AND H. WHITEHEAD. *Am. Chem. Soc., J.*, **61**, *pp.* 3580–3583, *Dec.*, 1939.—The adsorption of H_2 on pure CaO and on Cu dispersed in CaO has been measured at 650 mm. and at various temperatures. Cu, when dispersed in CaO, is a better adsorbent for H_2 than is the pure Cu. In general the activated adsorption of H_2 on CaO and on Cu dispersed in CaO resembles the adsorption of H_2 on MgO and on Cu dispersed in MgO. An equation has been suggested, the use of which permits the more uniform treatment of the data for Cu dispersed in oxides. AUTHORS.

351. Calorimetric investigation of physical and activated adsorption of H_2 on Ni. A. EUCKEN AND W. HUNSMANN. *Zeits. f. phys. Chem. Abt. B*, **44**, 3, *pp.* 163–184, 1939—The adsorption of H_2 on Ni has been investigated calorimetrically at 20°, 55°, 90°, 195° and 273° Abs., and by measurements of the rate of desorption at 20°, 83°, 195° and 273°. Both van der Waals, or physical, and activated adsorption were found to be present. The differential heat of the former was found to vary, as concentration of adsorbate increased, from 1 800 cal./mole to 400 cal./mole with a probable limiting value of 220 cal./mole, i.e. the heat of vaporization of H_2. From the rate measurements it is concluded that there are two types of centre on which activated adsorption occurs, associated with activation energies 9–10 kg.cal./mole (14% of the adsorbing surface) and 18–22 kg.cal./mole (86% of surface) respectively. The corresponding heats of activated adsorption increase almost linearly from 4 to 21 kg.cal./mole. No " tunnel effect ", i.e. a slow transition from the physical to activated adsorption at low temperature without requiring energy of activation, could be detected. S. J. G.

352. Adsorption of dipoles. A. R. MILLER. *Cambridge Phil. Soc., Proc.*, **36**, *pp.* 69–78, *Jan.*, 1940.—In the present paper Bethe's approximation is applied to the statistical treatment of the adsorption of dipoles considering (*a*) the electrostatic forces alone, and (*b*) the electrostatic and van der Waals forces jointly. In each case formulae are obtained for the adsorption isotherm and for the variation of the heat of adsorption with the fraction of surface covered. In case (*a*) the heat curves are compared with those obtained by Wang who used a different approximation to take into account the electrostatic interactions due to particles adsorbed on outer sites. The curves are of the same general shape; sources of differences in them are discussed. In case (*b*) the results are compared with those obtained by Roberts using a different method. This treatment confirms his result that the electrostatic and van der Waals forces give contributions to the variation of the heat of adsorption which are of opposite sign and almost counterbalance one another, so that the resultant variation in the heat of adsorption is very much less than would be expected from a consideration of forces of one type only. This comparison shows further that the distribution of particles on the surface, which is taken into account in the statistical method used in this paper, has a considerable effect on the variation of the heat of adsorption. AUTHOR.

353. Adsorption of naphthols. J. A. NABAR, P. M. BARVE, A. M. PATEL AND B. N. DESAI. *Indian Acad. Sci., Proc. Sect. A*, **10**, *pp.* 344–358, *Nov.*, 1939.—Adsorption of some dyestuffs of the naphthol AS series by cotton fibre has been studied in the presence of alcohol, sodium hydroxide, sodium chloride, sodium sulphate, sodium phosphate, soap, gum tragacanth and agar-agar and at different temperatures to understand the mechanism of the process of dyeing. It is observed that adsorption of the dyestuffs decreases with increasing amounts of alcohol, gum tragacanth and agar-agar, while it first increases, reaches a maximum and then decreases on adding increasing amounts of sodium hydroxide, sodium chloride, sodium sulphate, sodium phosphate and soap solutions. Regarding the effect of temperature on adsorption, it is found that (1) the rate of adsorption is greater at higher than at lower temperatures, (2) the equilibrium adsorption increases with the rise of temperature, and (3) the amount of increase of adsorption for a particular range of temperature is greater at lower than at higher temperatures. The results obtained become easily intelligible if it is assumed that the dye particles in colloidal condition and the process of dyeing is interpreted from that point of view. AUTHORS.

354. Specific surface of AgBr by radioactive and dye methods. I. M. KOLTHOFF AND A. S. O'BRIEN. *Am. Chem. Soc., J.*, **61,** *pp.* 3409–3414, *Dec.*, 1939.—A rapid incorporation of radioactive bromide into well-aged AgBr occurs when a solution of the former is shaken with the solid. Adsorbed wool violet and methylene blue limit the exchange between solution and solid to the surface layer only. Use of this is made in the radioactive determination of the specific surface of fresh and aged products of AgBr. Adsorbed gelatin inhibits the recrystallization of aged AgBr. Wool violet is found suitable for the determination of the specific surface of AgBr. From a solution containing an excess of Ag the amount of dye adsorbed is twice as great as that from a solution containing an excess of bromide. The saturated surface of an aged product of AgBr contained per 10·9 bromide ions 1 molecule of wool violet (excess Ag^+) or per 20·2 bromide ions 1 molecule of wool violet (excess Br^-), and per 11·6 bromide ions 1 molecule of methylene blue (excess Br^-). With a fresh product the following figures were found: 6·5, 14·5, and 5·2, respectively. AUTHORS.

355. Ageing of AgBr. I. M. KOLTHOFF AND A. S. O'BRIEN. *Am. Chem. Soc., J.*, **61,** *pp.* 3414–3419, *Dec.*, 1939.—The rate of ageing of AgBr is much greater in a medium containing an excess of bromide than of Ag, and it increases with the bromide concentration of the solution. The colloidal state of the precipitate in an excess of bromide is of importance with regard to the speed of ageing. The effect of shaking upon ageing indicates that upon longer periods of ageing in a liquid medium of suitable solving power a slight Ostwald ripening occurs. Adsorbed gelatin does not prevent the penetration of radioactive bromide into fresh AgBr. When the solubility of the AgBr in the ageing medium has reached a minimum value, recrystallization by way of solution becomes of no consequence. It is shown that fresh AgB is subject to a rapid thermal ageing in the dry state, even at room temperature. AUTHORS.

***356. Surface tension of H_2O and D_2O.** A. H. COCKETT AND A. FERGUSON. *Phil. Mag.*, **28,** *pp.* 685–693, *Dec.*, 1939.—The surface tensions (γ) of H_2O and D_2O at 0°–75°C. have been found by determining the pressure required to force a thread of the respective liquids along a horizontal capillary into such a position that the meniscus at the open end is plane; the accuracy of the method was tested by comparing values of the surface tension of a liquid in vertical and horizontal capillaries. The results are summed up in expressions of the form $\gamma = A - Bt^n$, where $A = 75{\cdot}23$, $B = 0{\cdot}066\,67$, $n = 1{\cdot}20$ for H_2O, and $A = 74{\cdot}64$, $B = 0{\cdot}108\,2$, $n = 1{\cdot}20$ for D_2O, t being measured in °C. By extrapolation, the values of the respective critical temperatures (T_c) at which γ vanishes are found to be 350°C. for H_2O and 382°C. for D_2O. The ratio of the effective molecular weight to the normal molecular weight between 5° and 40°C. is found, by applying Eötvos's rule, to be 3·4 for H_2O and 2·8 for D_2O; D_2O is less associated than H_2O. J. S. G. T.

357. Thermodynamics of interfaces in systems of several components. Parts I and II. E. A. Guggenheim. *Faraday Soc., Trans.*, **36,** *pp.* 397–412, *Feb.,* 1940.—In Part I, following Verschaffelt, the thermodynamic properties of a plane interface are derived by treating the interface as having a finite thickness. Formulae are derived for the dependence of the interfacial tension on the temperature and the composition of one of the two bounding phases; the pressure, not being an independent variable, is eliminated. It is shown that the formulae are invariant with respect to the thickness arbitrarily assigned to the interfacial layer. The treatment is correlated with that of Gibbs. In Part II it is shown that the formulae derived in Part I for plane interfaces may safely be applied to curved interfaces provided that the thickness of the inhomegeneous layer is negligibly small compared with its radius of curvature, a condition usually fulfilled in practice. When this condition is not fulfilled, the formulae cease to be applicable and at the same time the normal methods of measuring interfacial tension break down and the very meaning of interfacial tension becomes ill-defined. Author.

358. Structure and formation of immobile adsorbed film, e.g. O_2 on W. J. K. Roberts. *Cambridge Phil Soc., Proc.*, **36,** *pp.* 53–68, *Jan.*, 1940.—The theory is given of the structure and behaviour of immobile adsorbed films on a simple quadratic lattice in which each particle is so large that it occupies more than one site and makes it impossible for adsorption to occur on sites which are neighbours to that on which it is adsorbed. The results are obtained partly by statistical methods and partly by the use of a model of the film. The final or complete film of this type is not homogeneous and has gaps in it. The sites on the surface can be divided into two groups, the gaps occurring where regions of the surface occupied by particles adsorbed on one group and those occupied by particles on the other group meet. The number of these gaps or "boundary sites" is determined, and the possible configurations of particles in the boundary regions are discussed in detail. The results are considered in connection with some experiments on the adsorption of O_2 on W. In this case a second layer is formed over the boundary sites and the amount that can be so adsorbed or the number of "second layer sites" to which the boundary sites give rise is obtained. It is shown that numerically the experimental results for O_2 are in better agreement with the view that the first or very stable layer is a molecular layer of the above type than with the view that it is atomic. Author.

359. Contact angles of "built-up" multilayers. J. J. Bikerman. *Faraday Soc., Trans.*, **36,** *pp.* 412–417, *Feb.*, 1940.—A new method of determining large wetting angles is described. It is based on the measurement of the marks left by drops on solid surfaces. Wetting angles between air, water, and "built-up" multilayers are measured. They confirm the view that Y films are deposited when the angle is near 90°, while more hydrophobic surfaces give rise to X, and less hydrophobic ones to Z deposition. Langmuir's hypothesis connecting wetting angles with molecular orientation, and the usual theory of contact angles are briefly discussed. Author.

360. Adhesion of microscopic particles. A. v. Buzágh. *J. Phys. Chem.*, **43**, *pp.* 1003–1014, *Nov.*, 1939.—A summary of the author's newer experiments and conclusions in regard to the adhesion of microscopic particles, and on surface films. The forces operating in adhesion are taken as being indicated by the angle of inclination to the horizontal of a plate carrying the particles which are just beginning to slip. In different liquids adhesion is closely connected with the lyophilic properties of the substances. In solutions of strong electrolytes adhesion is due to the electrostatic forces, and in strong solutions of neutral salts in which the activity coefficients of the effective ions have the same values, the adhesion is influenced to the same degree. Ostwald's activity coefficient law holds good. In the case of weakly solvated disperse systems the active partner in coagulation is the dispersion medium. In the alcoholic series adhesion is due to intermolecular forces between adsorbed molecules, for the dielectric polarization determines the adhesion values irrespective of the particular alcohol concerned. Properties of the solid phase as well as those of the dissolved portion are of importance. The orientation of the adsorbed dipoles plays a decisive part in adhesion and also in heterogeneous catalysis. Albumins have a very individual effect, especially on quartz particles, and adhesion is at a maximum at the isoelectric point of the albumin. Fibres are not formed in diluted collagen solutions by the action of electrolytes at the isoelectric point. P. H. B.

See also Abstracts 302, 361, 435, 445, 553.

TIME.

See Abstract 342.

VISCOSITY AND FRICTION.

361. Flow of gases through metal capillaries at low pressures. H. Adzumi. *Chem. Soc. Japan, Bull.*, **14**, *pp.* 343–347, *Sept.*, 1939.—The author had previously shown [see Abstract 3929 (1937)] that the quantity of gas flowing through a capillary in unit time and under unit pressure difference is $K = 5{\cdot}236 \times 10^2 \; r^4p/\eta l + 3{\cdot}05 \times 10^4 \gamma \; \sqrt{(T/M)} \;\; (r^3/l)$, where K is the product of the volume and pressure of the gas and the coefficient γ is a function of pressure. The quantities of H_2 flowing through various metal capillaries have been measured and the variation of γ with the nature of the surface thus determined. An expression is derived theoretically for γ by consideration of the effect of the change in saturation of the gas molecules adsorbed on the surface as the pressure changes. This accounts for the minimum point on the K,p curve. J. B. W.

362. Viscosity of solutions of SO_2 in organic liquids. S. B. Cupp and H. E. Rogers. *Am. Chem. Soc., J.*, **61**, *pp.* 3353–3354, *Dec.*, 1939.—The viscosities and densities of many solutions of SO_2 in *n*-propyl, *i*-propyl bromide, and *n*-butyl bromide were measured at 25°. Expansion in volume, on mixing, was found in each case. The results support the well-known fact that when liquids show an expansion, on mixing, the fluidity of the solution is greater than the fluidity calculated from the fluidities of the pure liquids. Authors.

See also Abstracts 321, 347 and

1B. Analogy between fluid friction and heat transfer. T. v. Kármán.
39B. Viscosity of gases and molecular mean free path. A. E. Schul.

ASTRONOMY AND ASTROPHYSICS.

ASTRONOMICAL APPARATUS AND OBSERVATORY EQUIPMENT.

***363. Inverted pendulum in level measurements.** P. Lejay and M. Burgaud. *Comptes Rendus*, **209,** *pp.* 740–742, *Nov.* 20, 1939.—The authors describe modifications to the inverted elastic pendulum (" spring level ") already described [see Abstract 1500 (1938)]. Replacement of the old blade by one slightly shaped to a cylinder and notched at the edges results in a much more uniform sensitivity. Symmetry of sensitivity is obtained by adjusting the azimuth of the plane of oscillation, the verticality of this plane, and the position of equilibrium of the pendulum by means of controls on the base of the instrument. Creep of zero and hysteresis are much reduced by thermal treatment of the ends of the pendulum blade and by reducing its amplitude. Finally, the sensitivity can be reduced without reducing the precision of measurement by mechanical magnification of the motion of the blade. Three instruments have been fixed transversely on the Bamberg telescope used at Zi-Ka-Wei for latitude variation work; and two on the Prin transit circle. The results show that though it is valuable to have a check on measurements made by other means, little increase of accuracy in time observations from separate stars can be obtained by multiplying the level measurements. A. Hu.

COMETS AND METEORS.

364. CH bands in comet spectra. J. Dufay. *Astrophys. J.*, **91,** *pp.* 91–102, *Jan.*, 1940.—The intensity distribution in the $\lambda\,4\,300$ and $\lambda\,3\,900$ bands of CH is calculated according to the method of Swings and Nicolet [see Abstract 3987 (1938)], which has been slightly modified. A comparison with measurements of objective-prism spectra of 4 recent comets confirms the presence of the $\lambda\,4\,300$ band. That of the $\lambda\,3\,900$ band seems also established, in spite of the disturbing proximity of the strong $\lambda\,3\,883$ cyanogen band. Many radiations not considered in the 2 CH bands are also found. Finally, the possibility of detecting the Raffety band in comets is briefly discussed. Author.

COSMOGONY.

365. Cosmological constancy of the constants of fine structure. P. Jordan. *Zeits. f. Physik,* **113,** 9–10, *pp.* 660–662, 1939.—Dirac has suggested [see Abstract 1889 (1938)] that possibly e^2/hc is not absolutely constant but varies over cosmological periods of time. The constancy can be established empirically, however, within the limits of accuracy of our spectroscopic observations on distant heavenly bodies; for if e^2/hc were not constant the spectral frequencies of a distant nebula would not be altered, as they are, by a constant factor (Döppler and Hubble effect) but would be displaced relative to one another in a complicated manner. The constancy of the ratio m_P/m_E of the mass of the proton to that of the electron can also be established empirically. Its value depends on the binding forces within the nucleus, and the " radioactive clocks " provided by the discoloration haloes of radioactive minerals give strong evidence of the constancy of these nuclear forces, since they prove that the α-particle ranges have remained constant for approximately 10^9 years. S. J. G.

DYNAMICAL PROBLEMS (ASTRONOMICAL).

366. Permanency of configurations of rotating fluids with spheroids as surfaces of discontinuity of density. H. K. Ganguly. *Calcutta Math. Soc., Bull.*, **31**, *pp.* 69–76, *June*, 1939. *Zeits. f. Astrophysik*, **19**, 2, *pp.* 136–153, 1939. *In English*.—The author discusses the permanency of form of a spherical mass of fluid with a fluid core of different density in the case of rotation about an axis, points of the fluid at different distances from the axis having different rotations. In particular, the details of the case when the surface of discontinuity is a confocal spheroid are worked out and the conditions for the existence of a spherical core are fully determined. Author.

NEBULÆ.

See Abstract 378.

PLANETS.

367. Deduction of form of planets from force of gravity on their surface. C. Mineo. *Accad. Lincei, Atti*, **29**, *pp.* 529–535, *May* 20, 1939.—The author treats the problem of determining the surface of a planet when the gravity on the surface is known, in a general way. It is assumed that in zero-th order the surface be spherical and the angular velocity ω of the body zero. An integro-differential system is derived for the case that $0 < \omega < \omega_1$, which determines the *n*th approximation of a solution in the proximity of the known solution. It is shown that an infinitely great number of surfaces corresponds to the given gravity. L. K.

368. Secular inequality in mean motion of Pluto. H. Roure. *Comptes Rendus*, **209**, *pp.* 788–790, *Nov.* 27, 1939.—The author calculates, by a modification of Cauchy's method, the secular inequality in the mean motion of Pluto due to the perturbing actions of Jupiter and Saturn. The inequality is of the second order compared with the masses, and has a period of the order of 21 000 yr. A. Hu.

369. Visibility of new moon at Colombo, Ceylon. H. Jameson. *Roy. Astron. Soc., Occasional Notes, No.* 7, *pp.* 96–99, *Dec.*, 1939.—An account is given of observations of the visibility of the new moon, made at Colombo Observatory, Ceylon. The usual method in making these observations was to endeavour to observe the crescent in the telescope of a pilot balloon theodolite, afterwards looking along the sights of the telescope to pick up the moon with the naked eye. In this way it was possible to observe the moon at sunset altitudes considerably below the critical values given in a paper by Fotheringham (1910). Author.

STARS.

370. Stellar parallaxes determined at the Royal Observatory, Greenwich. *Roy. Astron. Soc., M.N.*, **100**, *pp.* 51–55, *Nov.*, 1939.—A continuation of the relative parallaxes obtained with the 26-in. refractor. [See Abstract 586 (1939).]

371. Distribution of absolute brightnesses of stars of different spectra type. J. Hopmann. *Ergeb. d. exakt. Naturwiss*, **18**, *pp.* 1–25, 1939.—A review of the statistics of stellar brightnesses was given by R. Hess in this periodical in 1924; the present report brings Hess's review up to date by consideration of the observational material in the light of the most important investigations published since 1924. The survey is divided into

4 main sections. In the first the fundamental magnitudes required in the statistical investigations are defined and discussed and the most important observational facts are presented. The second section deals with the distribution of absolute magnitudes of stars on a stellar-statistical basis. The third section is concerned with the distribution of absolute brightnesses of stars of the main sequence and in the fourth section is given a brief summary of the whole subject and general conclusions, the principal one of which is that the mass, luminosity, surface temperature and diameter of the overwhelming majority of stars appear the more closely inter-related as the observational data become the more extensive and exact. J. E. K.

372. Constants of star-streams from the Cape photographic proper motions of 18 323 stars. W. M. Smart and T. R. Tannahill. *Roy. Astron. Soc., M.N.*, **100,** *pp.* 30–44, *Nov.*, 1939.—The Cape photographic proper motions of 18 323 stars in the zone − 40° to − 52° and grouped together in 16 regions are analyzed according to the two-streams theory. The constants of Drifts I and II are given. The galactic co-ordinates of the vertex are (343°·2, + 0°·5). The equatorial co-ordinates of the solar apex are (265°·1, + 26°·1). The ellipsoidal constants are calculated from the derived values of the stream-constants. The results are compared with Jackson's results obtained from the analysis of the proper motions according to the ellipsoidal hypothesis. Authors.

373. Spectrographic orbits of components of Boss 2112. W. E. Harper. *Dominion Astrophys. Obs. Victoria, B.C., Publ.*, **7,** 8, *pp.* 149–154, 1939.—33 single-prism spectrograms of which all but 6 showed double lines were made the basis of the orbit, which yielded the following elements: $P = 11{\cdot}0764$ days, $e = 0{\cdot}107$, $V_0 = +\ 24{\cdot}80$ km./sec., $K_1 = 60{\cdot}69$ km./sec., $K_2 = 62{\cdot}03$ km./sec., $\omega_1 = 103^\circ{\cdot}84$ and $T =$ J.D. 2 422 374·453. The probable errors of a plate are large, that for the main component being ± 4·6 km./sec. and for the secondary ± 3·9 km./sec. The total luminosity of the secondary component is found to be 0·7 that of the primary. Author.

374. Theory of stellar continuous spectra. R. v. d. R. Woolley. *Observatory*, **62,** *pp.* 294–297, *Nov.*, 1939.—Observations of solar spectra are in fair agreement with the theory of radiative equilibrium in the outer layers and the assumption of an absorption coefficient for continuous radiation which is independent of wavelength. The importance of making more accurate measurements of solar absorption with improved technique is stressed with a view both to affording a better test of the theory and of providing for terrestrial physics data on which to base a more satisfactory theory of the continuous absorption coefficient than the existing Kramer's theory. J. E. K.

375. Colours of 1 332 B stars. J. Stebbins, C. M. Huffer and A. E. Whitford. *Mt. Wilson Observat., Contrib. No.* 621. *Astrophys. J.*, **91,** *pp.* 20–49, *Jan.*, 1940.—The colours of 1 332 stars of spectral types B, O,cB, and cA have been measured with a photocell at Madison or at Mount Wilson. The list includes nearly all O-B5 stars north of − 15° declination and brighter than visual magnitude 7·5, and, in addition, nearly all O-B2 stars north of − 40° of whatever magnitude to the limit of the *Henry Draper Catalogue*. The effective wavelengths of the cell with the two filters used and for an equal-energy source are 4 260 and 4 770 Å. The scale of the colours is close to two-thirds of the international scale. The probable error of a colour index is ± 0·02 to ± 0·03 mag. for Madison, and ± 0·01 to ± 0·02 mag. for Mount Wilson. The colour excesses of B stars are correlated with the intensities of interstellar lines. The space reddening is greater toward the centre than toward the anticentre of the galaxy. Even the brightest regions of the Milky Way are partially obscured. The absorption in the galaxy is not uniform but spotted and irregular. [See Abstract **3943** (1939).] AUTHORS.

376. Spectral types of stars of the North Polar sequence. P. C. KEENAN. *Astrophys. J.*, **91,** *pp.* 113–116, *Jan.*, 1940.—The spectral types of the stars of the North Polar Sequence brighter than photographic magnitude 11·2 were determined from spectrograms having a dispersion of 160 Å/mm. The new types average from one to two subdivisions later than the earlier estimates available from various sources. AUTHOR.

377. Theorems for a star with variable polytropic index. W. E. CANDLER. *Roy. Astron. Soc., M.N.*, **100,** *pp.* 14–24, *Nov.*, 1939.—It is shown that if the polytropic index of a star varies between two limits n_1 and n_2, then certain of the properties of the star are intermediate between those of the polytropic models with constant indices n_1, n_2. AUTHOR.

378. Galactic and extragalactic studies. Part II. Peculiar systems in Sculptor and Fornax. H. SHAPLEY. *Nat. Acad. Sci., Proc.*, **25,** *pp.* 566–569, *Nov.*, 1939.—The author describes and gives positions of two new objects in Fornax and Sculptor. These seem to be of average galaxy size, but have low intrinsic brightness and are devoid of supergiant stars. They are members of the local group of galaxies. Two classical Cepheids are in the Sculptor system; their faintness makes it improbable that they are merely superimposed on the system; this suggests 76 kiloparsecs for its distance. The Fornax system is at least as bright as the Sculptor, but their absolute magnitudes differ; it is inferred that the Fornax system is at least double the distance of the Sculptor. The total absolute magnitudes (− 10·5 and − 12) are of the same order as those of the brightest globulars such as the companions of the Andromeda Nebula and they resemble these in other features. [See Abstract 4250 (1939).] A. S. D. M.

379. Integrated photographic magnitudes of 68 globular clusters. W. H. CHRISTIE. *Mt. Wilson Observat., Contrib. No.* 620. *Astrophys. J.*, **91,** *pp.* 8–19, *Jan.*, 1940.—The photographic magnitudes of 68 globular clusters have been determined with a schraffierkassette attached to the 10-inch Cooke refractor. The scale was established by polar comparisons for an average of nine stars in each field. The cluster magnitudes have been compared by Seares with other determinations by Holetschek, Vorontsov-Velyaminov, Bernheimer, Vyssotsky and Williams, Stebbins and Whitford, and Shapley. AUTHOR.

380. Three supernovæ in Spiral NGC 3184. H. SHAPLEY. *Nat. Acad. Sci., Proc.*, **25,** *pp.* 569–571, *Nov.*, 1939.—In NGC 3184 three highly luminous variables, probably supernovæ, have appeared within 16 years (2 were at maximum in 1921), indicating great frequency in some external systems. No. 1 was 149″ south of the nucleus; No. 2 was 160″ S. and 32″ following the nucleus; No. 3 was 236″ S., 79″ east, not far from the position of the other two; it lies at the edge of a faint outlying spiral arm 1 500 parsecs from the nucleus in the plane of the spiral axis. A list of the observations is given. For two weeks in Dec., 1921, No. 3 equalled or exceeded in brightness, the whole spiral nebula in which it appeared. A. S. D. M.

381. Spectrophotometric study of Algol. J. S. Hall. *Astrophys. J.*, **90,** *pp.* 449–485, *Nov.*, 1939.—Photoelectric observations of Algol have been made in the visual region (5 500 Å) and in the infra-red (8 660 Å) near primary minimum and (at 8 660 Å only) at other phases. The time of primary minimum determined from the observations at 5 500 Å is identical with that found from those at 8 660 Å, within the error of measurement (estimated at 3 min.). The rectified depths of the primary and secondary minima determined in the infra-red are 0·761 and 0·129 mag. respectively. If the colour temperature of the B8 primary is taken as 15 000°, that of the bright side of the eclipsing companion is near 5 800°. Its dark side is about 200° cooler. Values of the reflection and ellipticity coefficients are determined from the infra-red light-curve: the former increases with wave-length, whilst the latter shows that the equator of the eclipsing companion is more eccentric than that of the primary. The question of the identity of a suspected third body is discussed at length; considerations of mass, photometric data, and the Russell diagram suggest that this is an early-type (A5 ?) main-sequence star. A. Hu.

382. Physical significance of the M-S differentiation. K. Wurm. *Astrophys. J.*, **91,** *pp.* 103–112, *Jan.*, 1940.—The relative prominence of the TiO and ZrO bands in spectral classes M and S is explained on the basis of different atmospheric conditions. S stars have a lower total atmospheric density than M stars of the same temperature. For a given temperature, T, the upper limit of the total density, ν, in S-star atmospheres, is given by $\nu = (\rho\mu^{-1}/1 - \mu^{-1})\ K_{TiO}\ (T)$, where $K_{TiO}(T) = \nu_{Ti}\nu_{O}/\nu_{TiO}$ designates the dissociation constant of the TiO molecule, ρ the abundance ratio of hydrogen to oxygen, and μ the abundance ratio of Ti to Zr. The low values of ν for S stars indicate that they are supergiants. Author.

See also Abstracts 366, 387, 466.

SUN.

383. Motion of eruptive prominences. R. G. Giovanelli. *Astrophys. J.*, **91,** *pp.* 83–90, *Jan.*, 1940.—A theory is suggested for the motion of such eruptive prominences as are associated with solar eruptions, according to which the constant velocities are maintained by radiation pressure of Lα and changes in velocity may originate in magnetic fields. The Lα line emitted by a single flocculus is shown to be strongly reversed. The total effect produced by several flocculi with different Lα widths is equivalent to that of an Lα contour with several maxima and minima. Provided the intensities are of the right order, to each hump in the contour there corresponds one stable velocity. If the prominence is electrically charged, on moving into a horizontal magnetic field it experiences a force which accelerates it along a horizontal direction, but the radiation exerts sufficient pressure to maintain an essentially constant vertical velocity. On moving into a field of the opposite direction, the prominence is deflected toward the vertical with an increased velocity and may again be subjected to a further radiation pressure, thus giving rise to an increase in velocity. Author.

384. General illumination during total solar eclipse. J. Q. Stewart and C. D. MacCracken. *Astrophys. J.*, **91,** *pp.* 51–71, *Jan.*, 1940.—Although Halley noted at the total eclipse of May 3, 1715, that diffused daylight from outside the moon's shadow was an important factor in determining the general brightness, its study since has been neglected. Observations of it during the long eclipse of June 8, 1937, at sea, from the

Isthmian freighter " Steelmaker," are given. Other relevant observations are reviewed. Remarks about the " globular corona " are included. A roughly approximate mathematical theory of scattering by pure air into the umbra is presented. The results are discussed for the noon point, as compared with the sunrise or sunset points, and for lunar shadows of different sizes and with the observer at varying distances off centre. From two methods it is concluded that the integrated brightness of the horizon glow at the noon point at mid-totality, June 8, 1937, was of the order 1/5 000th zenith sea-level sun, or 100 full moons. This estimate may be too large by a small factor ; but it is certain that diffused daylight far outshines the corona, even at the darkest eclipses. Careful observations of general brightness on October 1, 1940, will be desirable. It is emphasized that for study of the corona's structure a large shadow with the sun near the zenith is a requisite (and it is desirable also that the observer be at a high elevation). A list of six eclipses, 1940–1973, is given which come particularly close to this standard. In four of these the noon point is far at sea. AUTHORS.

385. Initial rate of growth of sunspots. J. C. DOBBIE. *Observatory*, **62,** *pp*. 289–293, *Nov*., 1939.—From observations of 88 sunspots of more than 6 days duration recorded in Greenwich Photoheliographic Results between the years 1914 and 1933, it is shown that in a large number of cases there must be an increase in the rate of growth of a spot in the initial stages prior to its first observation. J. E. K.

386. Mathematical characteristics of sunspot variations. Part II. J. Q. STEWART AND F. C. EGGLESTON. *Astrophys. J*., **91,** *pp*. 72–82, *Jan*., 1940.—The study is continued of the mathematical form $R = F\theta^a e^{-b\theta}$ as representing the course of sunspot numbers during a given outburst or cycle. The Case 2 solutions described in the first paper [see Abstract 182 (1939)] are found,, after detailed computation, to represent the observed annual numbers with an average residual, regardless of sign, of 7·2 Wolf numbers. Probably most of this difference is due to the inherent randomness which is superposed on the underlying smooth trend of spot numbers, but it also includes small systematic errors, perhaps due to a somewhat imprecise method of determining the time of the start of an outburst. The total discrepancy, O—C, regardless of sign, averages 16% of the average value of an annual sunspot number and this tends to be independent of the amplitude of a cycle. The systematic difference between observed and computed times of maxima, which in the first paper was considered to show that the mathematical form $F\theta^a e^{-b\theta}$ was only approximately applicable, can be attributed, on the other hand, it is suggested, to variations introduced by the Zurich method of smoothing the monthly numbers—upon which the "observed" times of maxima depend. The conclusion of the present paper is that the suggested mathematical form is not likely to be improved upon. Additional auxiliary tables for this function are given which are specially applicable to the problem of fitting the monthly numbers of an incompleted cycle. The problem of predicting the remainder of the present cycle, No. 17, is touched upon. AUTHORS.

387. Sun's speed of galactic rotation, determined from globular clusters. G. L. CAMM. *Roy. Astron. Soc., M.N.*, **100,** *pp*. 45–50, *Nov*., 1939.—The radial velocities of the globular clusters have been used by Edmondson to determine the solar motion relative to the clusters ; this value of 274 km./sec. has generally been accepted as the linear speed of galactic rotation of the sun. This conclusion will only be true if the clusters themselves are free from differential galactic rotation. With this in view, the clusters have been grouped according to their distances from the galactic axis, and the angular speed of rotation of each group relative to the sun has been found from the radial velocities. The variation of the angular velocity among the groups indicates directly that the clusters themselves are also sharing in the differential rotation. If it is assumed that the outermost six clusters—which appear to be rotating as a rigid body—have no mean rotation, the linear speed of the sun is found to be 410 ± 50 km./sec.; if the outer clusters are also rotating, then presumably the sun's speed exceeds 410 km./sec. The clusters are found to have a differential rotation, just as other types of object, but the speed of rotation is very much slower. This, together with the large velocity-dispersion and the spherical distribution of the objects in space, is all confirmation of Lindblad's theory of subsystems within the galaxy, each with its own speed of rotation. AUTHOR.

388. Stark effect and damping factor in the Fraunhofer spectrum. C. W. ALLEN. *Roy. Astron. Soc., M.N.*, **100,** *pp.* 4–9, *Nov.*, 1939.—The curve of growth has been determined for a number of Fe lines by plotting solar equivalent breadths against intensities measured in an iron arc. The damping factor so found has been plotted against the quadratic Stark effect, and the relation between the two has led to the value of 14 dynes per cm^2. for the electron pressure of the sun's reversing layer. AUTHOR.

389. Photometry of solar D lines. C. W. ALLEN. *Roy. Astron. Soc., M.N.*, **100,** *pp.* 10–13, *Nov.*, 1939.—The D lines have been photometered at the centre and limb of the sun. The corrections for finite resolving power were obtained from a comparison with strong terrestrial water-vapour lines. AUTHOR.

390. Atmospheric absorption of infra-red solar radiation at Lowell Observatory. Part II. A. ADEL AND C. O. LAMPLAND. *Astrophys. J.*, **91,** *pp.* 1–7, *Jan.*, 1940.—The intensity variations in the telluric spectrum between the limits 5·5 and 8μ are great. They are here empirically specified as functions of the atmospheric water-vapour content. [For Part I see Abstract 602 (1939).] AUTHORS.

See also Abstracts 374, 409.

GEOPHYSICS.

HYDROSPHERE, PHYSICS OF THE.

391. Tsunamis and earthquakes. B. GUTENBERG. *Seismological Soc. of America, Bull.*, **29,** *pp.* 517–526, *Oct.*, 1939.—Tsunamis ("tidal waves", "maremotos") may be produced by submarine volcanic eruptions, submarine slides started by earthquakes, submarine faulting, and atmospheric conditions. The hypothesis that at least some of the largest tsunamis have been produced by submarine slides with earthquake waves as a trigger force has been advanced by a number of seismologists. The macroseismic as well as the microseismic data of the Atacama earthquake of Nov. 11, 1922, indicate clearly that the fault movement occurred inland; the tsunamis originated from a submarine slide near a relatively feebly shaken stretch of the coast where the surface slopes steeply to a considerable depth. On gently sloping coasts, such as those of California, large tsunamis are rare and the relatively small tsunamis there are probably produced by faulting at the bottom of the ocean. AUTHOR.

392. Structure of Pacific Basin. B. GUTENBERG. *Science*, **90,** *pp*. 456–458, *Nov.*, 1939.—The character of the earthquake waves indicates absence over the Pacific area, as bounded by the " andesite " line and line of seismic epicentres, of the granitic and basaltic layer which elsewhere (though thinner under the Indian and Atlantic oceans) form the 25-30 mile thick " continental " layer, whence difference in structure below the Pacific is inferred. The boundary of this area is seismically the most active in the world. There are grounds for believing that the whole tract from California to Japan is moving southward relative to the continental areas east and west respectively of it. C. A. S.

LAND, PHYSICS OF THE.

393. Terrestrial heat flow in Great Britain. A. E. BENFIELD. *Roy. Soc., Proc.* A, **173,** *pp*. 428–450, *Dec.* 29, 1939.—Measurements are described which lead to values of the terrestrial heat flow in 5 bores in Britain. In the 2 deepest bores some evidence of the existence of an ice age was found. It is not possible from these measurements, however, to fix the date of the withdrawal of the ice sheet with any certainty, but the indications are consistent with the estimates derived from other evidence. Using 9 000 B.C. as this date to correct the measured heat flows, the mean equilibrium heat flow is found to be $(1\cdot42 \pm 0\cdot09)10^{-6}$ cal./cm^2.-sec., which is lower than has been previously estimated, but is higher than the mean heat flow in South Africa found by Bullard [see following Abstract]. The result of so low a heat flow on temperatures in the granite and basaltic layers is briefly discussed. AUTHOR.

394. Heat flow in South Africa. E. C. BULLARD. *Roy. Soc., Proc. A*, **173,** *pp*. 474–502, *Dec.* 29, 1939.—The thermal conductivities of 49 rocks from bores in South Africa have been measured. The mean heat flow calculated from these and from Krige's and Weiss's temperature measurements is $1\cdot16 \times 10^{-6}$ cal./cm^2. sec. This is much lower than the values usually quoted but is near Benfield's mean of $0\cdot98 \times 10^{-6}$ for bores in Europe. There is no foundation for the common opinion that the heat flow is lower in South Africa than in Europe. It is likely that many of the other supposed cases of abnormal heat flow are also unfounded. The low value of the heat flow shows that there cannot be more than 12 km. of rock with the radioactivity of surface granite under South Africa. This supports the reality of the " Intermediate Layer " of seismology and leads to very low temperatures at the base of the granitic layer. [See preceding and following Abstracts.] AUTHOR.

395. Borehole temperatures in the Transvaal and Orange Free State. L. J. KRIGE. *Roy. Soc., Proc. A*, **173,** *pp*. 450–474, *Dec.* 29, 1939.—Five deep boreholes in which temperatures were measured pass through dolomite, Ventersdorp lava, Witwatersrand quartzite, intrusive diabase and small thicknesses of other rocks. The geothermic step (increase in depth per deg. C.) varies over wide ranges, its mean values being highest in the dolomite and lowest in the lava. It is as a rule small above the water table, especially in the leached dolomite, and generally largest immediately below this level. In the dolomite below the water table the geothermic step is at first very large and in one case negative, and then decreases almost continuously downward, the lowest value reached being 310 ft. (95 m.) at its base. This decrease and the negative result both seem to be due to circulation of the ground water. The average below the water-table is 382 ft. (116 m.) at Gerhardminnebron, 465 ft. (143 m.) at Driefontein and 473 ft. (144 m.) at Doornkloof. In the Ventersdorp lava in the Jacoba borehole the geothermic step decreases from 345 ft. (105 m.) below the ground-water level to 217 ft. (66 m.) near its base, the mean being 248 ft. (76 m.), which is also the average at Doornhoutrivier below the first 1 000 ft. (300 m.), where the temperatures are affected by gas. In the Witwatersrand quartzites at Gerhardminnebron the range is from 470 to 300 ft. (143–91 m.) and the average is 366 ft. (111 m.). The value is 380 ft. (116 m.) at Jacoba and 385 ft. (117 m.) at Doornhoutrivier, in both of which holes the thickness of quartzite is small. At Doornkloof the range in the quartzite is from 365 to 335 ft. (111–102 m.) and the average 354 ft. (108 m.) which is also the mean value in two dykes passing through the quartzite. This agreement seems to show that the geothermic step in the quartzite is reduced by the presence of the dykes, and vice versa. [See preceding Abstract.] AUTHOR.

396. Radioactive sampling in Lake Ameno (Isle of Ischia). G. IMBÒ. *Ricerca Scientifica*, **10**, *pp*. 936–940, *Oct.*, 1939.—By radioactive sampling, the spatial and temporal characteristics of the line of earth fracture through Lake Ameno, have been examined. The details of the origin of the thermal and radioactive phenomena are still unsettled. F. C. C.

METEOROLOGY.

397. Solar and sky radiation at Helsingfors in 1934-1935. H. LUNELUND. *Soc. Scien. Fennica, Acta*, **3**, 3, [64 *pp*.], 1939. *In German.*—The paper consists chiefly of tables giving the intensity of solar radiation and total radiation (10-day and monthly averages) during 1934 and 1935, as well as over the period 1928–1935. The heat radiation is also tabulated and the results discussed in the light of the amount of cloud covering. The annual and 8-year averages of solar radiation and of the total radiation can be expressed as the sum of three harmonic terms. The solar radiation is measured on unit surface normal to the sun's rays. G. C. McV.

398. Solar and sky radiation on the Jungfraujoch during international polar year 1932/33. U. CHORUS. *Helv. Phys. Acta*, **12**, 6, *pp*. 537–552, 1939. *In German.*—The heat and the visible radiation from the sun and the sky respectively received on a horizontal surface were measured. The relationship between these radiations and the amount and type of cloud is discussed. The radiation from the sky is also discussed in connection with the duration of sunshine. G. C. McV.

399. Gliding and meteorology. G. T. WALKER. *Roy. Meteorolog. Soc., J.*, **65**, *pp*. 499–503, *Oct.*, 1939.—A short history of gliding is followed by an account of the meteorological information obtained from gliding. Down and up air currents have been found not only in thunderstorms but also in cumulus clouds that have not developed into cumulo-nimbus. The long clouds with axes parallel to the wind-direction have been found to rotate about their axes. Thermal up-currents are sometimes found to be discontinuous as if consisting of a series of bubbles of hot air. Other thermals are continuous and probably rotate about their axes. The launching of a glider, it is believed, is often the agency which starts a thermal current. G. C. McV.

400. Thermal aspects of the high-level anticyclone. T. R. Reed. *Monthly Weather Rev.*, **67**, *pp.* 201–204, *July*, 1939.—Recent information obtained from aircraft soundings is used to support the dynamical theory of Rossby, Namias and Simmers for the high-level anticyclone in the warm season over the Rocky Mts. [see Abstract 1571 (1939)]. The free-air isotherms indicate a high pressure dome over the Rocky Mts. and the mean winds at these levels show a clockwise rotation. The relatively high temperatures and humidities at these levels indicate the presence of tropical Pacific and Atlantic air masses. This additional moisture has a bearing on the high frequency of thunderstorms in this area. It is considered that convection from below accounts for the high thermal energy content.
R. S. R.

401. Influence of aerial scattering on visibility of distant sources. A. Marsat. *Comptes Rendus*, **208**, *pp.* 1494–1496, *May* 8, 1939.—A small area is illuminated by a distant source, not only by the direct light, but also by light emitted in other directions, and subsequently scattered by dust, etc., in the direction of the area. The author examines the effect of this consideration on the formulæ of Allard (used in connection with lighthouses) and of A. Blondel (applied to projectors generally) and concludes that the Allard formula is unaffected, while the Blondel formula needs modification, depending on the nature of the projecting system and the mode of observation used. A. C. M.

402. Measurement of light scattered by the upper atmosphere from a searchlight beam. E. A. Johnson, R. C. Meyer, R. E. Hopkins and W. H. Mock. *J.O.S.A.*, **29**, *pp.* 512–517, *Dec.*, 1939.—Rayleigh scattering from atmospheric gases in the path of an intense searchlight beam has been measured up to heights of 34 km. It is found that above a limit of haze, which varies on different days from 4–10 km., the scattering agrees with that calculated upon the assumption of the usual atmosphere. Clouds have been occasionally observed at heights of 12 km. It is shown that the method can be extended to allow measurements up to heights of 70 to 90 km. and to determine the distribution of ozone at low altitudes, as well as the study of other atmospheric problems. Authors.

403. Light of night sky. G. Frongia. *N. Cimento*, **16**, *pp.* 360–387, *July*, 1939.—The author gives a detailed report on the present state of our knowledge of the night sky. An account is given of the experiments on the intensity and degree of polarization of the light of the night sky and its spectrum with conclusive tables of the observed lines. A résumé of the interpretation of the spectrum is given together with a survey on the annual variations of the light. L. K.

404. Antarctic zone of maximum auroral frequency. F. W. G. White and M. Geddes. *Terr. Mag.*, **44**, *pp.* 367–377, *Dec.*, 1939.—The auroral data collected by expeditions to the Antarctic Continent are examined in order to determine the position of the zone of maximum auroral frequency. It is found that these data are not of a form permitting accurate estimation of the position of this zone but the approximate position has been determined from a general discussion of the data. It is found that the zone is probably circular with centre at 75° south and 129° east, a point near the magnetic axis-pole. The radius of the zone is about 18°. Authors.

***405. Improvement in radio-sounding balloons. Short-cycle radiosonde.** J. Piccard and H. Larsen. *Rev. Sci. Instruments*, **10**, *pp.* 352–355, *Nov.*, 1939.—Describes a new radiosonde which transmits information as to pressure, temperature and relative humidity every 4 sec. The thermometer scale, from − 60°C. to + 40°C., is divided into 100 equal divisions of 1 deg. each. The barometer scale is divided into 100 divisions, corresponding to equal increments of height each of 850 ft. The hygrometer scale is divided into 50 equal divisions. Provided the thermometer and the barometer themselves follow the changes of the weather elements with sufficient accuracy the maximum error of the thermometer is ± 0·5°C. and of the barometer, 425 ft., the average errors being only half as great. Because the cycle of readings is only 4 sec., each reading is repeated many times in succession and this allows temperature and altitude to be estimated within about 0·1% of the total range of the scale of each instrument. The carrier wave is modulated and the signals are given in ordinary Morse code. They can be received by ear or on a standard tape recorder without any special equipment. The radiosonde allows amateurs to pick up the signals long after the balloon has gone out of reach of the ground station. The weight of the completely equipped gondola is about 2 lb. S. A. S.

***406. Improved electric hygrometer.** F. W. Dunmore. *Bureau of Standards, J. of Research*, **23,** *pp.* 701–714, *Dec.*, 1939.—Where humidity readings are to be recorded graphically, remote from the point of measurement, or where the determination has to be very rapid, or in confined spaces, or at low temperatures the type of electric hygrometer now described is highly suitable. The unit consists of a 0·01 in. wall Al tube $1\frac{11}{16}$ in. long, coated with polystyrene resin and wound with a bifilar winding comprising 20 turns (of each wire) per in. of No. 38 AWG bare Pd wire. The unit is then coated with a film of partially hydrolyzed polyvinyl acetate with the addition of a small amount of Li Cl, the amount depending upon the humidity range to be covered by the unit. The electric resistance of the film between the two coils is a function of the humidity. The thin-walled Al tube quickly comes into equilibrium with air temperature, the use of Pd wire eliminates any ageing effect, the polystyrene resin gives a water-resistant surface of high electric resistance for the wire and water sensitive film, and finally all hysteresis effects due to adsorption of water are eliminated. The accuracy is from 2 to 3% over periods of several months and by using several units of different sensitivities in parallel the measurement of humidities from 10 to 100% is rendered possible. S. G. B.

See also Abstracts 340, 384, 390.

SEISMOLOGY.

407. New evidence for a change in physical conditions at depths near 100 km. B. Gutenberg and C. F. Richter. *Seismological Soc. of America, Bull.*, **29,** *pp.* 531–537, *Oct.*, 1939.—Seismograms of South American earthquakes at depths down to 260 km. recorded at Huancayo, Peru, are used to confirm and extend the conclusion that a slight decrease in the velocity of longitudinal waves occurs at a depth of about 80 km. Authors.

See also Abstracts 391, 392,

TERRESTRIAL ELECTRICITY AND MAGNETISM.

408. Effects of thunderstorms and lightning discharges on the earth's electric field. T. W. Wormell. *Roy. Soc., Phil. Trans. A*, **238,** *pp.* 249–303, *Sept.* 19, 1939.—The results of a series of observations of the potential gradient near the ground during thunderstorms is discussed. The recording instrument is intermediate in speed between the ordinary methods used for recording the potential gradient in fine weather and the high-speed oscillographs employed for detailed study of the variation of the field during short intervals of time. It yields a continuous record of the potential gradient and will also follow rapid changes up to a limit of less than 0·05 sec. The observations extended over the years 1926-36 and were mostly made during the summer months. After general remarks regarding the observations and details relating to individual storms the electric field at the ground during a thunderstorm is discussed and interpreted according to the observed field changes. The relative frequency of various possible types of complex field changes and the variation with the magnitude and distance of the discharge are considered. In connection with the duration of the field changes the effects of multiple strokes in one channel are explained and in complicated field changes the duration may be $>$ 1 sec. A frequency of lightning flashes of 1 flash/km^2. per year is obtained. The recovery of the electric field after a lightning discharge is often exponential but is in many cases more complicated. The results are used to revise the estimates given by Wilson for some of the fundamental quantities in a thundercloud. The objections raised by Simpson and Scrase to the Wilson mechanism of a thunderstorm are considered inadequate. R. S. R.

409. E-region of ionosphere during annular solar eclipse of April 7, 1940. E. O. HULBURT. *Terr. Mag.*, **44,** *pp.* 379–381, *Dec.*, 1939.—It is noted that ionospheric observations during the annular solar eclipse of April 7th, 1940, visible in Mexico, may provide data for testing various assumptions underlying the theory of solar-radiation origin of the E-region and may yield a fairly accurate value of the ionic recombination-coefficient α that occurs in the theory. E-region ionization-curves during the eclipse are worked out for a number of assumed values of α. Observations of solar flocculi during the eclipse may yield information concerning F. L. Mohler's suggestion of ionizing radiations from the flocculi [*Science*, 90, 137–138, 1939.] [See also Abstract 2009 (1939)]. AUTHOR.

410. Main features of daily magnetic variations at Sitka, Cheltenham, Tucson, San Juan, Honolulu, Huancayo, and Watheroo. J. BARTELS AND H. F. JOHNSTON. *Terr. Mag.*, **44,** *pp.* 455–469, *Dec.*, 1939.—Uniform sets of graphs are given expressing the average daily magnetic variations at 7 observatories as influenced by season, sunspot-cycle, and magnetic activity. The effect of disturbance on the daily mean values of the magnetic elements is discussed. International disturbed days are shown to be more disturbed around Greenwich noon than during the rest of the day. This second-order effect must be considered in studies of the disturbance-field. AUTHORS.

411. Earth currents. B. W. CURRIE. *Roy. Astron. Soc. Canada, J.*, **33,** *pp.* 313–323, *Oct.*, 1939.—After an historical introduction the method of measurement is explained and the means to avoid earth anomalies, contact potentials, chemical and temperature variations and electrostatic charges. The analysis of records at Keewatin shows a double wave for the northward component with minima at local noon and midnight and a slight increase of range during the day and in summer. The eastward component is a double wave with small amplitude in winter and 180° phase different from the northward component, but a larger amplitude in summer. The general effect of current changes is given. The relation of earth current and geomagnetic changes is not yet determined and is apparently complex. Physical evidence supports the relation for periodic and nonperiodic changes. The sites of large electrical current eddies in the upper air are quoted. R. S. R.

See also Abstract 432.

RADIOACTIVITY.

412. Chemical investigation of artificial radio-elements. P. Ray. *Science and Culture*, **5**, *pp.* 209–218, *Oct.*, 1939.—The various processes for the production and identification of artificial radio-elements are briefly classified. This is followed by a detailed account of recent work on the fission of U and Th and the methods used in detecting the resultant elements. [See Abstract 4274 (1938).] C. A. S.

413. Splitting of heavy nuclei by neutrons. C. J. Bakker. *Ned. T. Natuurk.*, **6**, 19, *pp.* 333–345, 1939.—A review is given of recent work on the disintegration of heavy nuclei by neutrons into nuclei of comparable sizes. The possibility of chain reactions is also discussed. D. S.

414. Resonance capture of slow neutrons and emission of γ-rays. I. Nonaka. *Phys. Math. Soc. Japan, Proc.*, **21**, *pp.* 594–608, *Oct.*, 1939. *In English.*—Intensity of γ-rays emitted from Fe, Cd, Hg and Bi by slow neutron capture was measured as a function of thickness of paraffin layer interposed between a D + D neutron source and a detector. From analyses of the obtained γ-ray intensity curves and measurements of energy by boron absorption method it is shown that Hg has a clear resonance neutron group of about 10 eV in energy, Cd has several groups of energies from several tens of eV to a few eV and the mean energy of these groups plus the residual part of the first group ($E_r = 0{\cdot}17$ eV) not absorbed by Cd filter of 0·43 gm./cm^2. thick is about 2 eV, Bi has a resonance group giving a maximum of γ-ray intensity at about $5 \sim 7$ cm. of paraffin thickness, and Fe has no distinct resonance groups. Author.

415. β-Ray spectrum of radio-chlorine. Y. Watase and J. Itoh. *Phys. Math. Soc. Japan., Proc.*, **21**, *pp.* 626–632, *Nov.*, 1939.—The β-ray spectrum of radio-chlorine (37·3 min.) was investigated by the use of the magnetic spectrometer. The β-rays are composed of at least two clearly resolved groups. The upper limit of the spectrum was 4·99 emV. Some discussions are given about the Fermi and K.–U. plots. From 2·6 emV to the end point of the spectrum Fermi plots lie on a straight line. By the absorption method, the maximum range of electrons was found to be 2·37 gm./cm^2. and the extrapolation of Feather's range-energy relation is discussed. Authors.

416. Radioactive As isotopes. R. Sagane, S. Kojima, G. Miyamoto and M. Ikawa. *Phys. Math. Soc. Japan, Proc.*, **21**, *pp.* 660–671, *Nov.*, 1939.—Six radioactive decay periods of As have been investigated by bombarding Br, Se, As and Ge with fast and slow neutrons and deuterons. General results obtained are summarized in a table. Authors.

417. Search for short range group of protons in the D-D reaction. F. E. Myers, R. D. Huntoon, C. G. Shull and C. M. Crenshaw. *Phys. Rev.*, **56**, *pp.* 1104–1106, *Dec.* 1, 1939.—A thorough search for short range protons arising from the D-D reaction has been made at bombarding energies up to 300 ekV, and at angles of 36°, 97°, and 142° to the incident deuteron beam. No evidence for such a group is found. The energy released in the reaction has been rechecked and is found to be in agreement with previous observations. Authors.

418. Resonance phenomena in disintegration of F by protons. W. E. Burcham and S. Devons. *Roy. Soc., Proc. A*, **173**, *pp.* 555–568, *Dec.* 29, 1939.—An investigation has been made of the short range α-particles emitted from F under proton bombardment. The α-particles were separated from the scattered protons by magnetic deflection. The results confirm the view that the resonant γ-radiation is emitted from an excited level of ^{16}O formed after emission of a low energy α-particle. A description is given of some measurements of the widths of the resonances for γ-radiation, using magnetically resolved beams of protons of high homogeneity. The results indicate that the resonances are very narrow in two cases examined, and considerably broader in the third. The excitation function for the emission of 5·9 cm. α-particles in the reaction ${}^{19}\mathrm{F} + {}^{1}\mathrm{H} \rightarrow {}^{16}\mathrm{O} + {}^{4}\mathrm{He}$ has been examined carefully. The excitation function shows resonant features superposed upon a background which increases with increasing proton energy. A discussion of some possible explanations of the resonant phenomena observed is given. AUTHORS.

419. Photodisintegration of deuteron in meson theory. H. FRÖHLICH, W. HEITLER AND B. KAHN. *Roy. Soc., Proc. A*, **174,** *pp.* 85–102, *Jan.* 12, 1940.—The authors have calculated the photoelectric effect of the deuteron on grounds of the meson theory of nuclear forces. In this theory the nuclear field is considered as electrically charged and, consequently, the light quantum can act on the nuclear field as well as on the proton. Because of the small mass of the meson, this effect is large. For the calculation a ${}^{3}S$ state was assumed for the ground state of the deuteron. The result is that at high frequencies ν the cross-section is much larger than in the old theory, and decreases only like $1/\sqrt{\nu}$ as compared with the $1/\nu^{3/2}$ law in the Bethe-Peierls theory. The angular distribution is also different. In addition to the $\sin^2\theta$ distribution about the direction of the γ-ray, there is a θ-independent term which becomes increasingly important for increasing energies. For the Li γ-rays (17 eMV), for instance, the cross-section is seven times larger than in the old theory and the ratio of the number of protons emitted parallel to the γ-ray to that emitted perpendicular to it is 0·7. AUTHORS.

420. Production of Ra and Po by deuteron bombardment of Bi. D. G. HURST, R. LATHAM AND W. B. LEWIS. *Roy. Soc., Proc. A*, **174,** *pp.* 126–136, *Jan.* 12, 1940.—The Cambridge cyclotron has been used to examine the reactions occurring when Bi is bombarded with deuterons of energies up to 8·7 eMV. The reactions found to take place are the formation of Ra E by a (*d*, *p*) process, and of Po by a (*d*, *n*) process. The Ra E subsequently decays into Po by the emission of an electron; with a 5 days' half-life. By determining the amounts of Po formed directly, and indirectly following the decay of Ra E, it has been possible to measure the relative yields of the (*d*, *p*) and (*d*, *m*) reactions at various energies of the deuteron. The excitation functions for the two reactions have been compared with the values to be expected on theoretical grounds. AUTHORS.

421. Scattering of α-particles by nitrogen. G. BRUBAKER. *Phys. Rev.*, **56,** *pp.* 1181–1183, *Dec.* 15, 1939.—A study has been made of the scattering of α-particles by N_2 into 4 angular ranges of mean angles 53°, 66°, 88°, and 104°. Anomalies in the scattering are observed for energies as low as 3·5 eMV. Curves showing the ratio of observed to Coulombian scattering as a function of energy show several maxima and minima. The form of the curves varies greatly with the scattering angle. AUTHOR.

422. Transition probabilities in double β-disintegration. W. H. FURRY. *Phys. Rev.*, **56,** *pp.* 1184–1193, *Dec.* 15, 1939.—The phenomenon of double β-disintegration is one for which there is a marked difference between the results of Majorana's symmetrical theory of the neutrino and those of the original Dirac-Fermi theory. In the older theory double β-disintegration

involves the emission of 4 particles, 2 electrons (or positrons) and 2 antineutrinos (or neutrinos), and the probability of disintegration is extremely small. In the Majorana theory only 2 particles—the electrons or positrons—have to be emitted, and the transition probability is much larger. Approximate values of this probability are calculated on the Majorana theory for the various Fermi and Konopinski-Uhlenbeck expressions for the interaction energy. The selection rules are derived, and are found in all cases to allow transitions with $\Delta i = \pm 1,0$. The results obtained with the Majorana theory indicate that it is not at all certain that double β-disintegration can never be observed. Indeed, if in this theory the interaction expression were of Konopinski-Uhlenbeck type this process would be quite likely to have a bearing on the abundances of isotopes and on the occurrence of observed long-lived radioactivities. If it is of Fermi type this could be so only if the mass difference were fairly large ($\epsilon \gtrsim 20$, $\Delta M \gtrsim 0{\cdot}01$ unit).
AUTHOR.

***423. Features of electrostatic generator and ion source for h.v. research.** I. A. GETTING, J. B. FISK AND H. G. VOGT. *Phys. Rev.*, **56,** *pp.* 1098–1104, *Dec.* 1, 1939.—A compact generator of the van de Graaff type is described in which several new features have been incorporated. Short-circuit current of 1 mA is available. When operating at 600 kV as voltage supply for accelerating protons or deuterons, 130μA of charged particles at the target have been obtained from an unusual low-voltage capillary arc source. In normal operation as a neutron generator, the equivalent of 15 curies of Ra-Be is readily produced by the reaction Li + D, and 60 curies by the D on D reaction.
AUTHORS.

***424. Coincidence counter for low energy β-particles.** D. ROAF. *Journ. Sci. Instruments*, **17,** *pp.* 19–20, *Jan.*, 1940.—A single counter replacing the usual pair of coincidence counters is described.
AUTHOR.

425. Determination of Pa in siliceous terrestrial and meteoritic material. W. C. SCHUMB, ROBLEY D. EVANS AND J. L. HASTINGS. *Am. Chem. Soc., J.*, **61,** *pp.* 3451–3455, *Dec.*, 1939.—The Pa contents of a granite and of a specimen of a meteorite (Pultusk), both high in silica, have been determined by the co-precipitation of the Pa with zirconium phosphate, followed by purification of the ignited pyrophosphate, employing a modification of the method of v. Grosse. The α activity of Pa thus isolated was measured on a recording α-counter and the concentration of Pa in the two specimens of terrestrial and of meteoritic material calculated. From these data and the corresponding Ra concentrations of the same specimens determined independently, the weight ratios Pa/Ra have been derived for two materials. From these results the conclusion has been reached that within the limits of error the age of U atoms in this specimen of the Pultusk meteorite is the same as for terrestrial U. The method is capable of estimating as little as 10^{-13} gm. of Pa per gm. of siliceous material, and the limit may probably be lower than this if larger samples are taken.
AUTHORS.

See also Abstracts 291, 340, 354, 355, 396, 513.

RADIATION.

ABSORPTION.

See Abstracts 340, 447.

EMISSION.

426. Radiation from a point charge revolving in a circular orbit. H. Poritsky. *Phil. Mag.*, **28,** *pp.* 617–631, *Dec.*, 1939.—The electromagnetic field of a point charge moving with uniform velocity along a circle is determined without using approximations. If the velocity is small compared with that of light, the result reduces to the Lorentz formula. The equations used are similar to those of Japolsky [see Abstracts 4379 and 4675 (1935)] but the applications made of them by Japolsky are criticized. R. P.

427. Generalized Wien's law. A. Carrelli. *Accad. Lincei, Atti,* **29,** *pp.* 435–441, *May* 6, 1939.—The emission of Pt, Ni_2O_3 and Co_2O_3 has been measured in the region 1–8 μ with a NaCl-prism as function of the temperature. The temperature interval covered is 770°–1 120° K. [see Abstracts 3042 (1935) and 206 (1938)]. The measurements show that for substances whose reflective power is a monotonous function of λ in the wavelength interval containing the wavelength of maximum emission, a generalized form of Wien's law holds, i.e. $\lambda_m T$ = const. This constant is related to the absorption of the substance. It follows from the measurements that the absorption increases with increasing wavelength in the case of Pt and Ni_2O_3 and decreases for Co_2O_3. [See Abstract 3989 (1939).] L. K.

428. Cosmic-ray showers and nature of mesotron. G. Bernardini and B. N. Cacciapuoti. *Ricerca Scientifica,* **10,** *pp.* 933–935, *Oct.*, 1939.—At 2 000 m. above sea-level, examination is made of the absorption curve for showers in material of weight 1 750 kg./cm^2. and of density comparable with that of water. It is found that the curve, regarded as a transition curve from water to lead, shows a step, somewhat similar to that exhibited by the transition curve from air to lead, which is obtained at 200-300 m. above sea-level. F. C. C.

429. Production of bursts and spin of meson. H. J. Bhabha, H. Carmichael and C. N. Chou. *Indian Acad. Sci., Proc. Sect. A,* **10,** *pp.* 221–223, *Oct.*, 1939.—Using the result of Massey and Corben [see Abstract 3782 (1939)] that the cross-section for the production of " knock-on " electrons depends on the spin of the meson, it is now shown that the frequency of large bursts at great depth, considered as a function of the size of the bursts, should be different according to whether the meson spin is assumed to be $\frac{1}{2}$ or 1. Experimental evidence appears to be strongly in favour of spin 1. R. P.

***430. Portable apparatus for recording bursts of cosmic-ray ionization.** C. G. Montgomery and D. D. Montgomery. *Rev. Sci. Instruments,* **10,** *pp.* 350–352, *Nov.*, 1939.—Describes a new apparatus, the design of which involves the use of two principles which, although not new, are not very frequently utilized. First, the change in potential of the collecting electrode of the ionization chamber in which the burst occurs is amplified by a degenerative, directly-coupled vacuum-tube amplifier, and second, the output pulse from this amplifier is applied to a " magic eye " indicator tube. This indicator tube acts as a cathode-ray oscillograph, and is directly photographed on continuously moving sensitive paper to give a record of the burst. Particulars are given of the degenerative amplifier, the indicator-tube oscillograph and the ionization chambers. S. A. S.

431. Decay of penetrating cosmic rays. Part II. E. M. BRUINS. *K. Ned. Akad. Wet., Proc.*, **42,** 8, *pp.* 740–744, 1939. *In English.*—Assuming that the mesotrons are created in the atmosphere at a height H above sea-level, and that their differential energy-spectrum then is of the form $N(E) = N_0E^{-s}$, their energy-spectrum and angular distribution are calculated as functions of altitude. The values $s = 2{\cdot}93$ and $s = 3$, and values between 10^{-6} sec. and 10^{-5} sec. for the mean life τ of the particles are used. The angular distribution is not affected by the decay of the mesotrons. Absorption curves in Pb up to 150 cm. are given for values of τ varying from 10^{-6} sec. to ∞. The change in the barometric effect due to the decay of the particles should be less than 20% for $\tau > 10^{-6}$ sec. [For Part I see Abstract 2048 (1939).] L. E. F.

432. World-wide variations of earth's magnetic field and intensity of cosmic radiation. O. GODART. *Phys. Rev.*, **56,** *pp.* 1074–1077, *Dec.* 1, 1939.—The observational data show that changes in the intensity of cosmic radiation are correlated with fluctuations of the magnetic field of the earth. It is suggested that the principal part of these fluctuations is due to variations in the intensity of the ionospheric currents. A rough schematic representation of these currents is assumed, as well as of their diurnal variations, and used to find the variation of the intensity of cosmic radiation caused by variations of the magnetic force due to these currents. A change of 0·4% in the intensity of cosmic rays in equatorial regions is thus obtained, in good agreement with experiment. At high latitudes discrepancies appear which, however, seem to be satisfactorily accounted for by the influence of the sun's magnetic field. Non-periodic variations seem to be accounted for by the same mechanism, except in the case of magnetic storms. AUTHOR.

***433. Apparatus for the isolation of monochromatic light of high intensity at 254 mμ.** L. J. HEIDT. *Science*, **90,** *pp.* 473–474, *Nov.*, 1939.—To obtain a high intensity of irradiation for photochemical work, a mercury " resonance " lamp was made from a spiral of quartz tubing with its ends, accommodating the electrodes, bent parallel to the axis of the spiral. Within the spiral was placed a cylindrical quartz vessel of annular section, the annular space being filled with dry Cl_2 which acted as a light filter. The substance to be irradiated was contained in a reaction cell inserted inside the light filter on the axis of the spiral. Measurements of the light flux obtained with this apparatus gave values of over 200 times those obtainable with a monchromator. W. S. S.

INTERFERENCE, DIFFRACTION AND SCATTERING.

434. Possibility of observing the interference of light from two different sources. F. ESCLANGON. *J. de Physique et le Radium*, **10,** *pp.* 391–398, *Sept.*, 1939.—Fourier's integral is applied to determine the possibility of observing interference between monochromatic light beams emitted by independent sources. The emission from each source is assumed to consist of a series of sinusoidal wave-trains distributed at irregular intervals over a total emission period θ. Since the wave-trains are of finite duration, the beams from the two sources, if passed through a spectroscope, must give continuous spectra. These spectra are superposed and will appear channelled if interference is observable. It is shown that for this to be the case, the resolving power of the spectroscope expressed as a frequency difference must be of the same order as the reciprocal of the total emission period θ. The implications of this result in relation to interference spectroscopes of the diffraction grating and interferometer types are discussed and it is concluded that, at present, observation of the interference phenomenon in question is impracticable. W. S. S.

435. Haidinger's rings in soap bubbles. C. V. RAMAN AND V. S. RAJAGOPALAN. *Indian Acad. Sci., Proc. Sect. A*, **10**, *pp.* 317–323, *Nov.*, 1939.—By suitable arrangements, which are described, it is possible to obtain soap bubbles which are perfectly uniform in thickness and to maintain them in that state. Such bubbles exhibit by transmission or reflection, interference figures consisting of concentric rings which are essentially of the same physical nature as the Haidinger rings due to a plane-parallel plate, besides being geometrically similar to them in configuration. Sixteen photographs are reproduced showing the interference figures of soap-bubbles of uniform thickness as also of the changes which occur in them when the films are allowed to drain. The question of the localization of the interference figures of a curved plate is discussed. AUTHORS.

436. Problems in diffraction of heat. A. N. LOWAN. *Phil. Mag.*, **29**, *pp.* 93–99, *Jan.*, 1940.—The object of this paper is to determine the temperature distribution in a semi-infinite solid whose boundary plane is impervious to heat except for an aperture of given shape, when the solid is subjected to an influx of heat of given rate. Rigorous solutions are obtained for the following cases: (A) The aperture is an infinite slit between two parallel lines. (B) The aperture is a circle of radius R. (C) The aperture is of finite extent and has any arbitrary shape. (D) The aperture consists of the half plane $x = 0, y > 0$. The method consists in first obtaining the Laplace transforms of the temperature function and subsequently performing the inversion of the Laplace transforms by means of standard methods in operational calculus. The above problem is the thermal equivalent of the problem of diffraction of electromagnetic waves. [For further elucidation of the mathematical technique see Abstracts 5230 (1933), 2086 (1934), 4588 (1937), and 2731 (1939).] AUTHOR.

437. Problems of coherence. P. H. VAN CITTERT. *Physica*, **6**, *pp.* 1129–1138, *Dec.*, 1939. *In German.*—The term "coherence" introduced by Zernike [see Abstract 3674 (1938)], is claimed to be equivalent to the term "correlation" introduced by the author 5 years previously [Abstract 1563 (1934)]. The idea is here extended to apply to sources of light not monochromatic, and it is found that in this case also the theorem enunciated previously holds, viz. the correlation is identical with the visibility of the interference pattern. General formulæ are deduced which take into account the magnitude of the light-source and the composition of the light in forming optical images. A. C. M.

438. Scattering of light in Bose-Einstein and Fermi-Dirac gas. B. N. SINGH. *Phil. Mag.*, **28**, *pp.* 635–641, *Dec.*, 1939.—The compressibility, and hence the density fluctuations, of a Fermi-Dirac gas are smaller, and those of a Bose-Einstein gas larger, than those of a classical gas. R. P.

See also Abstracts 401, 402, 479.

PHOTOCHEMISTRY (INCLUDING PHOTOGRAPHY).

439. Comparison of decomposition of azomethane by X-rays and by light. P. GÜNTHER AND F. GEBERT. *Zeits. f. phys. Chem. Abt. B*, **44**, 3, *pp.* 203–208, 1939.—Previous work shows that when azomethane is irradiated by X-rays in the presence of Xe, the number of molecules decomposed per ion pair formed begins to fall from a value of 4 when excess Xe is present. To test whether this reduction is due to the excitation act itself or to subsequent secondary changes, azomethane, in presence of various proportions of Xe, was irradiated in the same apparatus in separate experiments by (*a*) u.v. light of 3 660 Å; (*b*) X-rays. In (*a*) the quantum yield was 2 molecules per quantum absorbed and remained constant independent of concentration of Xe up to a proportion of 11 Xe : 1 azomethane; in (*b*) however, the number of molecules decomposed per ion pair diminished when the proportion of Xe to azomethane exceeded 2·5 : 1. It is concluded that the fall cannot be due to secondary processes—which presumably should operate equally in (*a*) and in (*b*)—but to the excitation process itself. S. J. G.

440. Chlorine-sensitized photochemical oxidation of chloral. W. A. ALEXANDER AND H. J. SCHUMACHER. *Zeits. f. phys. Chem. Abt.B*, **44**, 4, *pp.* 313–326, 1939.—The photochemical oxidation of chloral, sensitized by Cl_2, has been investigated at 70° and 90°. The stoichiometric equation is $2\,CCl_3CHO + O_2 \rightarrow 2\,COCl_2 + 2\,HCl + 2\,CO$. The reaction is homogeneous and the rate is given by $-d[CCl_3 \cdot CHO]/dt = k[I_{abs}]$, where I_{abs} is intensity of light absorbed. At 70° the quantum efficiency is 3×10^3 molecules per quantum and the temperature coefficient for 10 deg. rise is 1·14. The rate is independent of total pressure, pressure of reaction products, and, down to pressures of 2–3 mm., of the pressure of chloral and of O_2. The reaction is therefore a chain reaction. The following scheme is suggested: (1) $Cl_2 + h\nu \rightarrow 2\,Cl$; (2) $Cl + CCl_3CHO \rightarrow CCl_3CO + HCl$; (3) $CCl_3CO + O_2 \rightarrow P(CCl_3CO \cdot O_2)$ (where P denotes a peroxide of unknown constitution); (4) $P \rightarrow COCl_2 + CO + ClO$; (5) $ClO + CCl_3CHO \rightarrow COCl_2 + CO + HCl + Cl$. The liberated Cl carries on the chain from (2) again, the chain being probably terminated by the diffusion of P to the walls and decomposition there. S. J. G.

441. Photodecomposition of solid H compounds at low temperatures. L. FARKAS, Y. HIRSHBERG AND L. SANDLER. *Am. Chem. Soc., J.*, **61**, *pp.* 3393–3396, *Dec.*, 1939.—It is found that para-H_2 is formed when irradiating solid hydrogen iodide at low temperatures. Two explanations are given and discussed: (*a*) the H_2 primarily formed can be converted by the paramagnetic action of free I atoms; (*b*) the heat formed in the reaction $H + HI_{solid} = H_2 + I$ is dissipated in the solid. In the photolysis of formaldehyde and methyl alcohol under the same conditions normal H_2 is formed. This seems to indicate that the two H atoms forming a molecule are coming from the same formaldehyde or methyl alcohol molecule. AUTHORS.

442. Development of photographic emulsions in relation to the coating thickness. A. P. H. TRIVELLI AND W. F. SMITH. *Kodak Research Lab. Comm. No.* 722. *Phot. J.*, **80,** *pp.* 12–16, *Jan.*, 1940.—Taking as a basis Nietz's conclusion that the D/*t* curve represents a series of curves, each the result of phenomena which change with time of development, the following investigations were made: (1) An analysis of the D/*t* curve was started with the use of the log D/log *t* curve. (2) The log D/log *t* curve can be divided into three parts: a toe, a straight-line portion, and a shoulder. Since the straight-line portion of the curve often stretches out over a considerable range of development times, it offers an opportunity for a simple quantitative expression of a great part of the D/*t* curve. (3) For the straight-line part of the log D/log *t* curve, a simple equation can be derived to calculate the development velocities of different exposures. (4) The toe of the log D/log *t* curve shifts the straight-line portion of this curve. This shift can be determined quantitatively. (5) The shoulder of the log D/log *t* curve is caused by: (*a*) a change in the covering power of the reduced silver, and by (*b*) the approach of the end of the normal development reaction. (6) It was shown how thickness of coating of an emulsion influences development velocity. This explains the difference in speed and gamma of emulsions coated to different thicknesses. (7) The generalized conclusion is drawn, that for the investigation of an emulsion series, it is of great importance to experiment as much as possible with photographic material of the same coating thickness. AUTHORS.

443. Sensitometry of photographic papers. L. A. JONES AND C. A. MORRISON. *Kodak Research Lab. Comm. No.* 737. *Frank. Inst., J.*, **228,** *pp.* 445–470, *Oct.*; 605–622, *Nov., and pp.* 755–769, *Dec.*, 1939.—The fundamental principles and methods of the sensitometry of photographic papers established by Jones, Nutting, and Mees in 1914 are reviewed. The necessity for the use of intensity scale exposure rather than the older time scale methods is shown. An account of the evolution of the design of an optical wedge sensitometer to fulfil the required sensitometric specifications leads to the description of a new instrument used in this study of the sensitometric characteristics of photographic papers. Details of the complete sensitometric process are given. The resultant characteristic curves from the different types and grades of papers are described and interpreted. The typical characteristic curve of modern papers is discussed and a revised method of determining numerical values, which describe the curve for practical purposes, is given. The new interpretation of the shape of the shoulder region of the curve is significant with respect to the quality of tone reproduction. The new group of characteristic values—speed, maximum gradient, exposure scale, maximum density, and contrast—is defined and discussed. Numerical values obtained by the new sensitometric method are given in tabular form for most of the current types and grades of photographic papers. AUTHORS.

444. Halogen-silver films with hydrated cellulose. Part I. E. ELVEGÅRD AND G. SJÖSTEDT. *Zeits. f. wiss. Phot.*, **38,** *pp.* 157–179, *Aug.*, 1939.—Various methods are described in great detail for the preparation of halogenated Ag emulsions sensitive to light with hydrated cellulose (e.g. cellophane and similar substances) as dispersion agent. The most efficient photographic films with respect to photo-sensitivity and freedom from fog were acquired by immersion of cellulose films in a sequence of baths containing solutions of KI, $AgNO_3$ and Br_2 at special concentrations. The film is thereby first impregnated with AgI which subsequently is partially transformed into AgBr. References to previous work conclude a very complete experimental paper. H. H. HO.

445. Optical sensitization and adsorption of dyes on silver halide: state of adsorbed dye. E. P. DAVEY. *Kodak Research Lab., Comm. No. H*740. *Faraday Soc., Trans.*, **36,** *pp.* 323–329, *Feb.*, 1940.—Adsorption and sensitizing data have been obtained for certain sensitizing dyes adsorbed to silver halide. These particular dyes are adsorbed in two forms, each having a distinct absorption, and the two forms are often shown up by two stages in the adsorption curve. From the available data it is suggested that these dyes are adsorbed partly as single molecules attached by the N atoms to the surface, but possibly lying flat, and partly as molecules oriented as units packed in a parallel fashion, adsorbed edge-on, again by the N atoms. The influence of factors which may affect this orientation is discussed. AUTHOR.

446. Colour photography. D. A. SPENCER. *Roy. Soc. Arts, J.*, **87,** *pp.* 163–173 ; *Disc.*, 173–175, *Dec.* 29, 1939.—A survey of recent developments ; no fresh material is presented. A. H.

See also Abstracts 433, 477, 492, 493, 494.

REFLECTION, REFRACTION AND DISPERSION.

447. Infra-red dispersion of $CHCl_3$ and $CHBr_3$. M. A. PITTMAN. *J.O.S.A.*, **29,** *pp.* 358–363, *Sept.*, 1939.—The refractive indices of the two liquids were measured in the wavelength range 0·59 to 13·0 μ, the measurements being sufficiently closely spaced to follow the dispersion curves through the absorption bands. A formula derived by Herzfeld from the quantum-mechanical theory of dispersion is used to compute from the experimental curves the oscillator strengths of the 3·28 μ and 8·4 μ bands of $CHCl_3$ and the 3·28 μ and 8·8 μ bands of $CHBr_3$. W. S. S.

See also Abstracts 297, 317, 331, 340, 489, 569.

SPECTROSCOPY.

448. Spectra of Y V and Zr VI. F. W. PAUL AND W. A. RENSE. *Phys. Rev.*, **56,** *pp.* 1110–1113, *Dec.* 1, 1939.—The Br I isoelectronic sequence has been extended to Y V and Zr VI. Spectrograms covering the region from 150 to 1 000 Å were obtained with a 3 m. grazing incidence vacuum spectrograph having a dispersion of 1·0 Å/mm. at 500 Å. The separations of the ground doublets $4s^2 4p^5$ were predicted by the regular doublet law and observed to be 12 068 cm^{-14} for Y V and 15 600 cm^{-1}. for Zr VI. With the aid of the irregular doublet law and Moseley diagram curves, most of the expected $4s4p^6$, $4s^2 4p^4 d$ and $4s^2 4p^4 5s$ levels with $j \leq 5/2$ were found. 42 lines of the spectrum of Y V and 46 lines of the spectrum of Zr VI have been classified. The absolute term values of the $2P^0{}_{3/2}$ ground levels of Y V and Zr VI were estimated to be 620 000 cm^{-1}. and 798 000 cm^{-1}. respectively. AUTHORS.

449. Isotopes and hyperfine structure. L. SIBAIYA. *Current Science*, **8,** *pp.* 462–465, *Oct.*, 1939.—A brief review of the present position of the theory of isotope displacements in hyperfine structure. C. B. A.

450. Isotope shift in Mg. J. P. VINTI. *Phys. Rev.*, **56,** *pp.* 1120–1132, *Dec.* 1, 1939.—A theoretical investigation is made as to whether nuclear motion alone can account for observed fine structure in Mg. Both by calculation with explicit radial functions and by the choice of theoretical parameters to fit observed shifts, it is shown that the values of the core-valency parameters in the theory are not at all negligible, so that a 2-electron model would not be permissible. The signs and values of shifts of certain specified lines are examined. A test of the theory independent of the use of explicit radial functions is carried out by adjusting the theoretical parameters so as to give the observed shifts of the lines under consideration, and these parameters are shown by the estimate of corresponding *f* values to be reasonable in absolute and relative values. With certain acceptable assumptions, it is shown that if the shifts in Mg are due to nuclear motion alone, then three relations connecting the specific shifts may be deduced, and these relations lead to the prediction, for any member, of values for total shifts. It is concluded that the quantum theory of nuclear motion,

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without the assumption of non-Coulomb nuclear fields or of nuclear spins, gives a good qualitative explanation of the fine structure. N. M. B.

451. Spin of C^{13}. C. H. TOWNES AND W. R. SMYTHE. *Phys. Rev.*, **56,** *pp.* 1210–1213, *Dec.* 15, 1939.—C^{13} was concentrated in a Hertz diffusion system to an abundance of 50% and enough 35% heavy C was obtained for a measurement of the nuclear spin of C^{13}. The spin was determined from the relative intensities of the Λ-type doublets of two lines of the $0-0$ Swan band of $C^{13}-C^{13}$. These doublets are so close that a Lummer-Gehrke plate crossed with a 21-ft. grating was needed to obtain sufficient resolving power. An intensity analysis of the combined interference patterns of the two doublets proves that the C^{13} nucleus obeys the Fermi-Dirac statistics and strongly indicates a spin of 3/2. This is in disagreement with a spin of $\frac{1}{2}$ predicted for this nucleus from the Hartree nuclear model but is the value predicted by the α-particle model. AUTHORS.

452. Visible and U.V. spectra of solid bodies. G. JOOS. *Ergeb. d. exakt. Naturwiss.*, **18,** *pp.* 78–98, 1939.—The scope of this survey of the principal results of investigations of the electron spectra of solid bodies, in particular crystals, can be judged from the following list of headings under which the subject matter is presented :—Conditions for appearance of sharp spectral lines from crystals ; production of spectra ; classification of lines ; electron terms and factors influencing them ; influence of pressure and temperature on electron terms ; selection rules for transitions ; Zeeman effect ; connection with magnetism ; concluding remarks. A list is given of 45 references to original papers. J. E. K.

453. Fundamental rotation-vibration band of NO. R. H. GILLETTE AND E. H. EYSTER. *Phys. Rev.*, **56,** *pp.* 1113–1119, *Dec.* 1, 1939.—The fundamental rotation-vibration band of NO has been measured with the high dispersion of an echellette grating spectrometer, and has been subjected to a complete analysis. The resulting constants have been carefully combined with those derived from the existing electronic data to yield the following molecular constants for the normal state of the molecule ; $\omega_e = 1\,904{\cdot}03\ ({}^2\Pi_{1/2})$, $1\,903{\cdot}68\ ({}^2\Pi_{3/2})$ cm^{-1}. $\omega_e x_e = 13{\cdot}97$ cm^{-1}., $\omega_e y_e = -1{\cdot}20 \times 10^{-3}$ cm^{-1}., $B_e = 1{\cdot}7\,046$ cm^{-1}., $I_e = 16{\cdot}423 \times 10^{-40}$ gm. cm^2., $r_e = 1{\cdot}1\,508$ Å. AUTHORS.

454. Infra-red study of chloral hydrate and related compounds. M. M. DAVIES. *Faraday Soc., Trans.*, **36,** *pp.* 333–344, *Feb.*, 1940.—Infra-red measurements on chloral hydrate in solution have shown a considerable interaction between the OH groups and the adjacent CCl_3 radical. This interaction is related to the peculiar stability of the compound and similar results for analogous structures are presented. The relation of the frequency change in the OH group between two structures and the corresponding energy difference is discussed. The unsatisfactory nature of those estimates assuming identical anharmonicity factors in the two structures is indicated. Electrostatic energies are evaluated for interactions involving the OH group. With reasonable assumptions, these are found to account for the observed effects in a considerable variety of cases, and it is suggested that the magnitude of the resonance contribution to the stability of the " hydrogen bond " may often be negligible. AUTHOR.

455. Emission band spectrum of SnF. T. YUASA. *Phys. Math. Soc. Japan, Proc.*, **21,** *pp.* 497–507, *Sept.*, 1939. *In French.*—An emission band spectrum attributed to SnF has been obtained from a Geissler discharge through the vapour of SnF_4. The bands stretch from 4 600 to 6 300 Å, and are red-degraded. They form two systems with identical lower state vibrational constants. The bands can be represented by the formula $\nu = \left.\begin{matrix} 20\,132\cdot 25 \\ 17\,814\cdot 25 \end{matrix}\right\} + (418\,n' - 1\,n'^2) - (580\,n'' + 2\,n''^2)$, where $n' + \mathrm{U}' + \frac{1}{2}$, $n'' = \mathrm{U}'' + \frac{1}{2}$. The lower state is regarded as $^2\Pi$ with a doublet separation of 2 318 cm^{-1}., in agreement with results obtained by Rochester [see Abstract 215 (1938)] with SnF u.v. systems. The present system was not found in absorption. A. C. M.

456. Excitation function of first positive system of N_2 bands. R. Bernard and R. Fouillouze. *Comptes Rendus*, **209,** *pp*. 647–650, *Oct*. 30, 1939.—Using thoriated W cathodes, working between 1 200 and 1 500°C. in order to minimize the continuous background, it has been possible to observe the 1P bands of N_2 excited by collision with 9- to 30-V electrons. From 7·5 to 10·5 V, the excitation function increases very slowly; it then rises rapidly to a sharp maximum at 13·5 V, after which it decreases gradually. It is independent of pressure. These results are compared with those obtained for the 2P bands. Addition of He or of Ne produces no modifications. C. B. A.

457. Molecular association and near infra-red absorption spectrum of cholesterol. G. Stora and R. Freymann. *Comptes Rendus*, **209,** *pp*. 752–754, *Nov*. 20, 1939.—The problem of the association of cholesterol (I) and ovolecithin (II) has been studied by examination of the near infra-red absorption spectra (about 0·96 μ). Compounds containing an (OH) group show one of two bands $3\nu(\mathrm{OH})_v$ and $3\nu(\mathrm{OH})_s$ depending on whether the molecules are non-associated or associated respectively. Results with (I) are analogous to those obtained with alcohols: molten (I) at 150° shows the $3\nu(\mathrm{OH})_v$ band at 0·9 674 μ very intensely due to the destruction of molecular association at the high temperature; the intensity of this band increases progressively with dilution with CCl_4; the de-associating effect of $CHCl_3$ is greater than that of CCl_4 which is, in turn, greater than that of C_6H_6. The absence of the $3\nu(\mathrm{OH})_v$ band for 10% solutions of (I) in acetone, ether, aniline, and dimethylaniline indicates very strong association between molecules of (I) and solvent molecules. (I) does not associate with palmityldiethylaminoethyl alcohol iodide. Solutions of (II) in $CHCl_3$ and CCl_4 exhibit no band characteristic of (OH) at 0·96 μ. This may indicate the existence of an internal anhydride or the phenomenon of intramolecular chelation. Evidence for the association of molecules of (I) and (II) has not been obtained since the solvent CCl_4 has a de-associating effect. W. R. A.

458. Infra-red studies of porphyrin molecule. C. S. Vestling and J. R. Downing. *Am. Chem. Soc., J.*, **61,** *pp*. 3511–3513, *Dec*., 1939.—The infra-red absorption of two dipyrrylmethenes, the copper complex of one of them, etioporphyrin I, and etiohemin I chloride has been measured. Replacement of acidic hydrogens with metal atoms eliminated nitrogen-hydrogen absorption in the dipyrrylmethenes and in etioporphyrin I. The possibility of N–H–N bonding in these compounds is discussed. Authors.

459. Infra-red study of bonding of H in N compounds. A. M. Buswell, J. R. Downing and W. H. Rodebush. *Am. Chem. Soc., J.*, **61,** *pp*. 3252–3256, *Dec*., 1939.—An extensive study of N compounds has been made in the region of the fundamental absorption of the N–H group. It is found that the absorption due to the N–H groups is distinctly weaker than for the O–H group and there is a much greater variability in the characteristic frequency. Infra-red absorption is a less reliable criterion for bonding of H attached to N than for H attached to O. There is no positive proof of association involving the formation of N–H → N bonds but there is a strong tendency toward association if the H is somewhat acidic. The characteristic absorption produced by association of molecules containing the peptide linkage may be due to enolized H. [See Abstract 4956 (1938).] AUTHORS.

460. Absorption spectrum of I_2 in its principal solvents. F. CENNAMO. *N. Cimento*, **16**, *pp.* 355–359, *July*, 1939.—The absorption spectrum of I_2 in the visible and u.v. spectrum has been studied in organic solutions. It is found that the I_2 shows an absorption spectrum very similar to that of its vapour in solvents whose dipole moment is zero but that for solvents with a finite dipole moment the spectrum shows great dissimilarities for different solvents. L. K.

461. Emission spectrum of hydrocarbon flames. E. C. W. SMITH. *Roy. Soc., Proc. A*, **174**, *pp.* 110–125, *Jan.* 12, 1940.—An examination has been made of the emission of stationary and explosion flames of ethylene in air, enriched air and O_2, and of the explosion flames of propane in air, together with a chemical examination of the condensable products of reaction. The explosive limits of these mixtures have also been determined. It is suggested that the carbon deposition observed at pressures in excess of some critical value with ethylene mixtures may be due to the polymerization of C_2 molecules. It would appear that the " green flame " regions observed by Townend and Chamberlain and by Townend and Hsieh [see Abstract 1714 (1939)] for various ethers and hydrocarbons are determined solely by the stability of the same species. It is suggested that the so-called " ethylene flame bands " which also occur in the spectra of propane and other hydrocarbon flames are possibly emitted by an isomeric formaldehyde molecule, HC·OH. AUTHOR.

462. U.V. absorption spectra of ethylene, deutero-ethylene and some alkyl-substituted ethylenes. W. C. PRICE AND W. T. TUTTE. *Roy. Soc., Proc. A*, **174**, *pp.* 207–220, *Feb.* 1, 1940.—The absorption spectra of C_2H_4, C_2D_4 and C_2H_3D have been investigated in the region 2 000–1 000 Å. The spectra are interpreted as arising from the excitation and photo-ionization of the " π " electrons of the double bond. The ionization potential obtained by the extrapolation of successive excited states in Rydberg series is 10·45 V probably accurate to 0·03 V. The spectra of (*a*) propylene, (*b*) butene 2 (*trans*) and cyclohexene, (*c*) trimethyl ethylene, (*d*) tetramethyl ethylene, are shifted progressively to long wavelengths corresponding to reductions of their ionization potentials to (*a*) 9·6 V, (*b*) 9·2 V, (*c*) 8·75 V and (*d*) 8·3 V. This is probably a charge transfer or inductive effect brought about by the additional alkyl groups. The spectrum of *cis*-dichloro-ethylene is discussed and its low ionization potential of 9·6 V is attributed to resonance to ionic states similar to those postualted to explain the ortho-para substituting properties in the phenyl halides. The value 11·3 V obtained for *trans*-dichloro-ethylene by Mahncke and Noyes is attributed to a non-bonding " $p\pi$ " Cl electron. AUTHORS.

463. U.V. absorption spectra of conjugated dienes. W. C. PRICE AND A. D. WALSH. *Roy. Soc., Proc. A*, **174**, *pp.* 220–234, *Feb.* 1, 1940.—The absorption spectra of butadiene, isoprene, $\beta\gamma$ dimethyl butadiene and chloroprene have been investigated in the region 2 500–1 000 Å. They are all very similar. The first strong bands appear as short diffuse progressions involving the C = C vibrational frequency but no vibrational structure is observed in the bands below 1 600 Å. The latter are interpreted as vibrationless electronic transitions converging to the first photo-ionization limit $\chi_1^2\chi_2$ of the "mobile" electrons. The extrapolation of successively excited states in Rydberg series gives the following very accurate values of the molecular ionization potentials. Butadiene 9·02 V; isoprene 8·81 V; $\beta\gamma$ dimethyl butadiene 8·67 V; chloroprene 8·79 V. The diminution in the ionization potential with alkyl substitution is interpreted as a simple inductive effect. The diminution in chloroprene involves the mesomeric as well as the inductive effect. The non-appearance of vibration bands accompanying the Rydberg transitions is a direct result of the resonance. As the electron is shared between two bonds, its removal has only one half the effect on each and this is apparently inadequate to cause the appearance of vibrational bands. Attempts are made to evaluate the resonance integral from various features of the spectra and from the ionization potentials. It is pointed out that the main difficulty with Mulliken's N → V interpretation of the strong bands of the dienes (also that of Sklar's for benzene, etc.) is that the shorter wave-length transitions are interpreted as being the more strongly anti-bonding. The reverse is observed to be the case as judged from the vibration frequencies appearing in the spectra. AUTHORS.

464. Theory of the colour of dyes. L. PAULING. *Nat. Acad. Sci., Proc.*, **25,** *pp.* 577–582, *Nov.*, 1939.—It has become recognized during recent years that the colour of dyes is associated with the resonance of electric charge from atom to atom of the dye molecule, and the author has expanded this idea into a theory of colour which permits the quantitative calculation of the frequencies and intensities of the absorption bands of dyes. It is shown from examples that the structures with negatively charged C are less stable than those with positive C, so that only structures corresponding to resonance of a positive charge about the molecule are considered. To set up the secular equation the following assumptions are made: (1) all structures with a given charge distribution may be combined to a resultant structure with energy H_{ii} given by known values of resonance energies and bond energies. (2) The wave functions for these resultant structures are mutually orthogonal. (3) The exchange integral H_{ij} between two resultant structures has the constant value ϵ if the structures differ through the motion of a charge from one C atom to an adjacent C atom (or slightly different values for C — O, C — N, etc.); for two structures differing by larger motion of the charge H_{ij} is negligibly small. A secular equation set up in this way is similar in form to that obtained in the molecular-orbital treatment; it differs from the latter in respect to the interpretation of the exchange integrals and the variation in H_{ii} values. Each root of the equation represents an energy level of the molecule, whereas in the molecular-orbital treatments sums of roots are taken to obtain the molecular energy levels. The agreement between predicted and observed values of the integrated absorption co-efficient is good. H. H. Ho.

465. Systematics of band-spectral constants. Part V. C. H. D. CLARK. *Faraday Soc., Trans.*, **36,** *pp.* 370–376, *Feb.*, 1940.—The applicability of the empirical relation $k = \mathrm{D}r_e^3n^{\frac{1}{2}}$, where D is dissociation energy, r_e equilibrium internuclear distance, n group number, and k a period (or sub-period) constant, has been tested for non-hydride di-atoms in ground states and compared with formulae suggested by other authors (Morse, Huggins, Sutherland). Consistent results are obtained by Sutherland's and the author's formulae, provided that the product occurring in

Sutherland's expression has periodic character with group number, attaining maximum values in group X in each period. The results also confirm recent work of Fox and Martin on CC linkages. The corresponding relation for hydride di-atoms is found to be $l = Dr_e^4 n$. Consistent results are obtained by Sutherland's and the author's methods. The results indicate that k is sensibly constant in the KK period for elementary di-atoms, and possibly for other cases, and that l is constant in the KH period, but that in other periods k, l are sensitive to electron configuration type. Comparison with experimental data gives generally satisfactory results. A method is hereby suggested for the rapid approximation of D from r_e, whereby certain unknown dissociation energies are calculated. (For Part IV see Abstract 4962 (1938).] AUTHOR.

466. Quantal theory of continuous absorption by various atoms in their ground states. Part I. Atoms from B to Ne. D. R. BATES. *Roy. Astron. Soc., M.N.*, **100,** *pp.* 25–29, *Nov.*, 1939.—The coefficients for the continuous absorption by B, C, N, O, F and Ne atoms in their ground states are calculated, over a wide frequency range, by quantal methods. The investigations shows that, although the order of magnitude of the coefficients is similar to that indicated by the various rough approximations that have been employed, the variation of the absorption with frequency is in many cases completely different. This arises from the fact that it is a bad approximation to represent the wave functions of the initial and final states of the electron involved in the absorption process as hydrogen-like wave functions with the same effective nuclear charge. For the atoms concerned the best simple approximation is to take this effective nuclear charge, as given by Slater's rules, for the bound wave function, but as unity for the wave function representing the ejected electron.

AUTHOR.

467. Molecular spectrum of iodine excited by fluorescence (in the presence of nitrogen) and by active nitrogen. A. ELLIOTT. *Roy. Soc., Proc. A*, **174,** *pp.* 273–285, *Feb.* 1, 1940.—The fluorescence spectrum of I_2 vapour in the presence of N_2 at 1 atm. pressure has been photographed. The spectrum contains 4 separate band systems. A vibrational analysis has been carried out for 2 of these systems, one of which is often referred to as the " continuum " 3 425, and which is due to a $^1\Sigma_u^+ \sim {}^1\Sigma_g^+$ transition. The effect of varying N_2 pressures on the intensities of the bands has been examined. The spectrum of I_2 vapour excited by active N has been photographed and compared with the fluorescence spectra of I_2 vapour in the presence of N_2. AUTHOR.

468. Zeeman effect in Xe II and Xe III spectra. C. J. HUMPHREYS, W. F. MEGGERS AND T. L. DEBRUIN. *Bureau of Standards, J. of Research*, **23,** *pp.* 683–699, *Dec.*, 1939.—The Zeeman effect in the spectra of singly and doubly ionized Xe has been observed in the laboratory " Physica " in Amsterdam and at the National Bureau of Standards. The source used in the case of the former observations was a Back lamp consisting of a spark between metal electrodes operated in an atmosphere of the gas, whereas at the National Bureau of Standards a Geissler tube placed transversely between the poles of the magnet was employed. Measureable patterns were obtained for 130 lines of Xe II and 62 of Xe III. Reasonably good agreement between the observations from the two laboratories was obtained. Analysis of observed patterns has permitted computation of 61 *g* values associated with levels of Xe II and 34 of Xe III. Most of the patterns are only partially resolved. Use of the formulae of

Shenstone and Blair to set up observation equations which were adjusted by the method of least squares has permitted calculation of a fairly consistent set of *g* values. The *g*-sum rule was tested where possible and was found to be satisfied very closely in case of two different electron configurations in Xe^+. Observed *g* values depart considerably from those calculated by the Landé formula in most instances. A vector coupling scheme intermediate between LS and *Jj* is indicated for both Xe^+ and Xe^{++}. The analysis of Xe II has not required important changes as a result of the Zeeman-effect observations. No changes of J values are indicated. In two instances, pairs of levels are interchanged in the term tables. In Xe III, the revisions are confined mostly to the group of levels of ^2D parentage from the $s^2p^3\cdot 6p$ configuration. Changes in the assignment of J values are required in 5 instances.. AUTHORS.

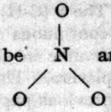
469. Recent Stark effect investigations. H. VERLEGER. *Ergeb. d. exakt. Naturwiss.*, **18**, *pp.* 99–154, 1939.—This paper comprises a general survey of Stark effect phenomena in which particular prominence is given to the most significant recent observations and theoretical developments. The scope of the survey may be judged from the following list of headings and sub-headings under which the subject matter is presented : (I) General experimental procedure ; (II) Stark effect of H atoms, general results and determination of splitting factor ; displacement effect, simultaneous effect of electric and magnetic fields, asymmetrical intensities, sudden changes of field, ionization by electric fields, quadratic effect, Stark effect of H fine structure, axiality of light emission ; (III) Stark effect of atoms with several electrons, inert gases, other elements ; (IV) Stark effect of molecules. J. E. K.

470. Stark effect of Hg I. Y. ISHIDA AND S. HIYAMA. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 935, *pp.* 390–416, *Oct.*, 1939. —The Stark effect for Hg I, lines due to both singlet and triplet terms, has been studied for field strengths up to 560 000 V/cm. The patterns obtained resemble closely those for neutral He and Mg, especially when the principal quantum numbers are large. The results for the various lines studied are tabulated at length. A. H.

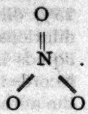
471. Stark effect of C I. Y. ISHIDA, T. TAMURA AND M. FUKUSHIMA. *Inst. Phys. and Chem. Research, Tokȳo, Sci. Papers, No.* 936, *pp.* 417–418, *Oct.*, 1939.—Details are given of some observations on lines of neutral C within the range $\lambda\lambda$ 4 000–5 400. A. H.

472. Optical catalysis of Raman effect and new technique for its production. K. PROSAD AND D. K. BHATTACHARYA. *Zeits. f. Physik*, **113**, 9–10, *pp.* 637–659, 1939.—The absorption bands of solutions of $KMnO_4$ and $Er(NO_3)_3$ (" optical catalysts ") dissolved in the liquids under examination were determined in the usual manner using an incandescent electric lamp as source ; the fluorescence bands of the same solutions were determined by a Raman technique with sunlight as source and a 3–5 hr. exposure. The frequency intervals between correctly chosen absorption and fluorescence band-pairs are found to be, within close limits, either identical with Raman frequency intervals, say ν_1, ν_2, ν_3, etc., or are " combination intervals," e.g. $2\nu_1 + 2\nu_2 + \nu_3$. The solvents studied were H_2O, HNO_3, methyl, ethyl, propyl and butyl alcohols, acetone and pyridine ; the last two gave only combination intervals, but the rest, particularly water, gave wide ranges of both simple and combination intervals. A brief discussion of the theory of the effect is given. S. J. G.

473. Structure of nitric acid and of methyl nitrate. J. Chedin. *J. de Physique et le Radium*, **10**, *pp.* 445–454, *Oct.*, 1939.—The structure of the NO_3^- ion (dil. HNO_3), 100% HNO_3 and methyl nitrate have been studied by examination of Raman spectra data. The frequencies which would result from each of the possible structures are calculated on the basis of classical mechanics, and are compared with the observed Raman frequencies. The NO_3^- ion is thus found to be

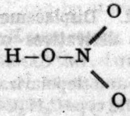


and not

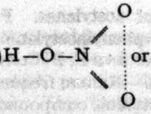


. On Raman grounds conc. HNO_3 may be either

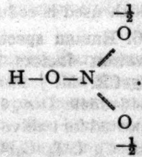
(a)



, (b)



or (c)



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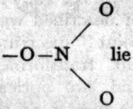
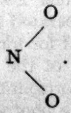
The dotted lines denote singlet linkages, i.e. single shared electrons. In (*c*) this shared electron is donated by the N to the O, thus yielding a semipolar linkage; the calculations are too inexact to decide between (*a*), (*b*) and (*c*) but on general grounds (*c*) is to be preferred. Methyl nitrate shows a similar Raman spectrum to 100% HNO_3 and its structure is accordingly similar. By examining the polarization of the scattered ray, conclusions have been drawn as to the spatial structure: the atoms



lie in one plane P_1, the linkage C–O lying in a second plane P_2 normal to P_1, and bisecting the angle



. The angle C–O–N is 116°. S. J. G.

474. Occurrence of overtone lines in Raman effect. S. Bhagavantam. *Indian Acad. Sci., Proc. Sect. A*, **10**, *pp.* 224–228, *Oct.*, 1939.—If the anharmonicity in the motion of a diatomic molecule is taken into account, and is assumed to be given by Morse's potential function, the intensity of the first harmonic in the Raman effect becomes from 1/150 to 1/400 of the intensity of the fundamental. R. P.

475. Complete Raman spectrum of glycerin. B. D. Saksena. *Indian Acad. Sci., Proc. Sect. A*, **10**, *pp.* 333–340, *Nov.*, 1939.—Using an improved method of distillation it has been possible to get a sample of glycerin comparatively free from fluorescence, which was further reduced on cutting off the 4 046 excitation with a filter of $NaNO_2$. The Raman spectrum of the purified material showed 21 lines and an O-H band. The lines are 2 955 (12) *v. br.*, 2 880 (12) *br.*, 1 466 (8) *s.*, 1 378* (0), 1 309* (1) *s.*, 1 246 (2) *v. br.*, 1 194* (1), 1 112 (5) *s.*, 1 085* (2), 1 048 (8) *v. br.*, 975 (2) *s.*, 919 (5) *br.*, 862* (2) *s.*, 847 (6), 817 (3) *s.*, 674 (2), 546 (1) *di.*, 489 (6) *br.*, 434 ($\frac{1}{2}$) *s.*, 419 (3) *br.*, 370* ($\frac{1}{2}$), 328* (1) and the O-H band extends from 3 200–3 564. The frequencies marked with an asterisk have been observed for the first time. The polarization of the lines has also been investigated for the first time—there are 12 polarized and 3 depolarized lines in the spectrum. A general assignment of frequencies as C-C, C-O, C-H, δ (C-H) and the deformation C-C-O oscillations has been made. The effect of dilution of glycerin in water has been investigated up to a dilution of 10 cm^3. of glycerin in 100 cm^3. of water. The line 674 becomes more diffuse as dilution progresses, and increases in frequency by 15 cm^{-1}. at 25% dilution. The ν (C-H) frequencies also show a splitting at higher dilutions. The continuous spectrum accompanying the Rayleigh line in liquids is unobservable in glycerin although the strong Raman lines are recorded in the picture. This is in agreement with the result reported by the author in a previous paper that the depolarization of the scattering in glycerin measured spectroscopically is not greatly diminished when the slit-width used is reduced to the minimum. AUTHOR.

476. Raman spectra of acetylenes. Part II. Displacements and depolarization factors for phenylacetylene and derivatives of the type $C_6H_5C{\equiv}CR$. M. J. MURRAY AND F. F. CLEVELAND. *Am. Chem. Soc., J.*, **61,** *pp.* 3546–3549, *Dec.*, 1939.—Raman frequencies and depolarization factors are reported for twelve acetylenic compounds of the type $C_6H_5C{\equiv}CR$, where R is H, Cl, CH_3, C_2H_5, CH_2OH, CH_2Cl, CH_2Br, CH_2CH_2OH, CH_2CH_2Cl, $CHOHCH_3$, $CH_2C_6H_5$, and $CH_2CH_2CH_2Cl$. The two lines near 2 200 cm^{-1}. were found to have the same depolarization factors, thus indicating that one frequency cannot correspond to a symmetrical, the other to an asymmetrical, vibration as Glockler and Davis have stated to be the case for dimethylacetylene. [For Part I see Abstract 324 (1939).] AUTHORS.

***477. Push-pull photoelectric photodensitometer for determining fine structure in u.v. absorption spectra.** J. R. LOOFBOUROW. *J.O.S.A.*, **29,** *pp.* 535–537, *Dec.*, 1939.—The photoelectric photodensitometer described was developed for determining fine structure from " match-point " spectrum photographs. It consists of a push-pull photocell circuit, transformer coupled to an amplifier and cathode-ray oscillograph, and two optical systems with a.c. operated light sources for projecting the spectra on to the photocell slit and for forming an image of the wavelength scale which indicates the region of the spectrum being matched. As the projected spectra are moved horizontally across the slit, a change in phase occurs in the a.c. output of the photocell circuit on passing through a match point. The corresponding change in oscillograph pattern indicates whether the absorption is increasing or decreasing, and permits true match points to be distinguished from decreases in intensity due to dense spectrum lines in matching line spectra. AUTHOR.

See also Abstracts 340, 389, 390, 447.

TRANSMISSION.

478. Theory of double Fizeau toothed wheel. H. E. IVES. *J.O.S.A.*, **29,** *pp.* 472–478, *Nov.*, 1939.—The effect produced by moving a Fizeau toothed wheel apparatus in a direction parallel to the axis of rotation of the wheels (hence in the direction of propagation of the light) is discussed at length. The paper is entirely theoretical in character and it is concluded that the Fitzgerald contraction (in conjunction with the Larmor-Lorentz change of rate of a clock in motion) suffices to elucidate all problems connected with the behaviour of rotating discs set in uniform translatory motion. A. H.

See also Abstract 401.

VISION.

***479. New interferometer for studying resolving power of retina.** F. Schupfer. *Ricerca Scientifica*, **10,** *pp.* 852–855, *Sept.*, 1939.—This instrument employs Le Grand's method [see Abstract 2148 (1935)] for determining the resolving power of the retina independently of the resolving power of the dioptric system of the eye. A biprism is used to produce two coherent images of a point source at the cornea of the observing eye. The beams diverging from these images enter the eye, interfere and produce a fringe system on the retina. The spacing of the fringes can be varied continuously, by displacement of the biprism, until the limit of resolution is reached. Means are provided for altering the orientation of the fringe system on the retina, so that the possible existence of "retinal astigmatism" can be studied. W. S. S.

480. The Koremetron: An instrument for measuring pupillary diameters. R. C. Jones. *J.O.S.A.*, **29,** *pp.* 531–534, *Dec.*, 1939.—The theory and construction of an apparatus which permits the rapid measurement of pupillary diameters is presented. This instrument, the koremetron, is portable, and uses the same principle as that involved in observing entotpical phenomena. Author.

See also Abstracts

140B.	Spectral light sensitivity of the human eye. H. König.
145B.	Visual efficiency in coloured light. C. Dunbar.

X-RAYS.

481. M-series absorption spectra of Au, Tl, Pb, Bi, Th, and U. W. Polaczek. *Akad. Wiss. Wien, Ber.*, **148,** 2*a*, 1–2, *pp.* 81–87, 1939.—The M_V lines of the above elements and in the case of U and Th also M_{IV} were photographically registered, employing a Siegbahn vacuum-spectrograph. A "Seeman" tube with exchangeable anticathodes was used as a source of radiation. The absorbing elements were applied in the form of thin foils, thickness $0{\cdot}4\mu$–10μ, obtained by standard methods. Photographs, taken with the usual experimental precautions, were measured with a microphotometer. The lines Au-M_V and Th-M_V were found to be complex, consisting of 3 and 2 peaks (or "steps"), respectively. These cannot be accounted for by any known characteristic radiations. The widths of the lines observed, in terms of wavelength (λ), varied between 8 and 29×10^{-11} cm. and amounted to 94×10^{-11} cm. in case of Au. All values for λ obtained by measurement are smaller than the theoretical values computed from $L_{III} - L_{III}{\cdot}M_V = M_V$. H. O. S.

482. X-ray diffraction applied to chemical analysis. W. P. Davey. *J. of Applied Physics*, **10,** *pp.* 820–830, *Dec.*, 1939.—The author deals in detail with the principles involved, with illustrative examples showing how it is applied in actual practice. He shows that it should be possible to calculate the proportions of two unknowns from the following data: (1) Volume of the specimen exposed. (2) Molecular weight. (3) Number of atoms or molecules per unit cell. (4) Scattering power of the unit cell. (5) Structure factors of the atomic planes used. (6) Lorenz factor. (7) Polarization factor. (8) Absorption factor under differing conditions. (9) Intensity of the primary beam. (10) Intensity of the diffracted beam, measured as integral of the interference curve. Some of these quantities are very difficult to determine accurately, the scheme is too cumbersome for routine analysis, and too involved in abstract theory for patent work. Special cases, in which most of the ten quantities cancel out, are likely to be too restricted for any practical value. D. R. H.

See also Abstracts 439, 513.

HEAT.

CALORIMETRY.

483. Specific heat of superconducting Hg, In and Tl. A. D. MISENER. *Roy. Soc., Proc. A*, **174**, *pp.* 262–272, *Feb.* 1, 1940.—Threshold field curves for Hg, In and Tl were accurately determined by a magnetic method down to a temperature of 1·1°K. By least-square methods, polynomials were fitted to these curves and from these the specific heat of the metals in the superconducting state was calculated using the formulae of Gorter and Casimir. The values obtained for Tl agree with the direct determinations of Keesom and Kok. The specific heat of superconducting Hg and Tl varies as T^3, that of In as T^4. AUTHOR.

484. Specific heats of ethylene halides. W. E. RAILING. *Am. Chem. Soc., J.*, **61**, *pp.* 3349–3353, *Dec.*, 1939.—The heat capacities of 1, 2-dibromoethane, 1,2-dichloroethane, and 1,2-bromochloroethane have been measured over the range 90–320°K. Heats of fusion and transition have been measured for these compounds. Certain phenomena in connection with the thermal history of these compounds and its effect upon the specific heat have been interpreted in the light of restricted intramolecular rotation in these compounds. AUTHOR.

485. Specific heat of Pt between 0° and 1600°C. F. M. JAEGER AND E. ROSENBOHM. *Physica*, **6**, *pp.* 1123–1125, *Dec.*, 1939. *In English.*—As the result of about 600 measurements, extending over several years, made with their metal block calorimeters, the authors consider that they have determined the specific heat of Pt with such precision that it may henceforth be used as a means of calibrating calorimetric apparatus. The results are here given as empirical functions of temperature which fit the experimental data very closely. L. G. C.

486. Thermal capacity of pure iron. J. H. AWBERY AND E. GRIFFITHS. *Roy. Soc. Proc., A*, **174**, *pp.* 1–15, *Jan.* 12, 1930—The energy changes associated with the Curie point of iron are not concentrated closely around that point, but influence the specific heat curve over a wide range. In the range from 50°C. to the Curie point, which was found to occur at 775°C., the specific heat rises fairly regularly except that there is a slight increase above the regular increment, amounting to rather less than 2% at its maximum, over a broad band of temperature centred around 200°C. Above the magnetic point, the specific heat falls rapidly, but the thermal effect of the magnetic transformations is still visible when the α–γ transformation sets in. At this point, iron changes from a body-centred to a face-centred lattice. It was found that the transformation is at least in part a true phase-change involving a latent heat, since energy could be added for a considerable time without any rise of temperature. The latent heat associated with the change was measured as $3 \cdot 9_1$ cal./gm. It was further found that the transformation is double; the main peak occurs at 903°C., but after the specific heat has fallen to 0·37 cal./gm., it rises again to a small but definite peak at 908°C., before finally falling to the value for the face-centred variety, known usually as γ-iron. The specific heat of the latter was found to be approximately 0·14 cal./gm.

AUTHORS.

487. Heat of fusion of ice. A revision. N. S. OSBORNE. *Bureau of Standards, J. of Research,* **23,** *pp.* 643–646, *Dec.,* 1939.—The results of measurements of the heat of fusion of ice made at the National Bureau of Standards [see Abstract 1547 (1915)] have been revised by one of the original experimenters, using more recent data for the heat capacity of water, which is involved in the calculations. The revised value, obtained by weighting the results of four independent series of measurements and expressed in terms of the present calorimetric unit of energy, is 333·5 International j./gm. with an estimated uncertainty of 0·2 int. j./gm.

AUTHOR.

See also Abstract 492.

CONDUCTION.

488. Attempt to measure the velocity of propagation of heat in liquid He II. E. GANZ. *Cambridge Phil. Soc., Proc.,* **36,** *pp.* 127–130, *Jan.,* 1940.—An interim account of two experiments which have been undertaken in order to measure the velocity of propagation of heat in liquid He II contained in capillary tubes. The first experiment involved the use of a steady heating current and the second made use of short heat impulses. The conclusion is reached that heat energy can be transmitted over considerable distances in liquid He II and in adsorbed films of the liquid a few atomic diameters thick on the surface of the containing tube, at a velocity of the order of 10^4 cm./sec. This velocity is of the same order of magnitude as the zero-point velocity of the He atoms. R. W. P.

See also Abstract 436.

DILATATION.

See Abstract 317.

FUSION AND SOLIDIFICATION.

489. Physical properties of purified 2, 2, 3-trimethylpentane. D. B. BROOKS, F. L. HOWARD, AND H. C. CRAFTON, JR. *Bureau of Standards, J. of Research,* **23,** *pp.* 637–641, *Dec.,* 1939.—A sample of 2, 2, 3-trimethylpentane prepared synthetically was purified by fractionation in an automatically controlled 6-m. helix-packed column. The resulting product was of such purity that a good freezing point could be obtained. The freezing point and melting point were determined in an apparatus in which the rate of cooling of heating could be accurately controlled. Other properties measured included the boiling point and its variation with pressure, and refractive index and density and their variations with temperature.

AUTHORS.

TEMPERATURE.

***490. Potentiometer circuit for portable optical pyrometer.** R. C. MACHLER. *Rev. Sci. Instruments,* **10,** *pp.* 386–388, *Dec.,* 1939.—A potentiometric circuit designed for the measurement of small currents is described, together with its application to the measurement of the filament current in a portable optical pyrometer. Its feature is the elimination of several elements from the conventional potentiometer with the advantages of increased portability and simplicity of operation. AUTHOR.

THERMOCHEMISTRY.

491. Modern combustion data for some non-votalile compounds containing C, H and O. J. W. RICHARDSON AND G. S. PARKS. *Am. Chem. Soc., J.*, **61**, *pp.* 3543–3546, *Dec.*, 1939.—A bomb calorimeter was calibrated and then used for precise measurements of the heats of combustion of the following 11 substances at 25° and constant volume: β-methylnaphthalene, phthalic anhydride, phthalic acid, anthracene, phenanthrene, stilbene, pyrene, *n*-hexadecane, cetyl alcohol, triphenylbenzene and polyisobutylene. From these experimental results the corresponding heats of combustion and heats of formation at constant pressure were calculated. AUTHORS.

***492. Photocalorimeter. Quantum efficiency of photosynthesis in algae.** J. L. MAGEE, T. W. DEWITT, E. C. SMITH AND F. DANIELS. *Am. Chem. Soc., J.*, **61**, *pp.* 3529–3533, *Dec.*, 1939.—A small calorimeter is described capable of measuring a rate of heat change as small as a millionth of 1 cal./sec. It is designed to admit light and thus give a measurement of heat changes accompanying photochemical reactions. The thermal efficiency of photosynthesis by green algae has been measured. About four fifths of the red light absorbed in living algae is converted into heat, leading to a quantum yield of about 0·08 molecule per quantum absorbed. AUTHORS.

493. Calculation of bond strengths. M. BURTON. *J. Chem. Phys.*, **7**, *pp.* 1072–1075, *Dec.*, 1939.—The hypothesis that predissociation, as evidenced by sudden broadening of the rotation lines in an absorption spectrum, may be used to establish the strength of the bond involved in the associated photochemical act is re-examined. It is shown to lead to incorrect conclusions in the few cases where its use seemed applicable. New values are derived for the C–C and C–H bond strengths in various compounds. The values are consistent among themselves and with observations in reaction kinetics but show a small spread due to secondary effects of adjacent double bonds. In free acetyl and formyl radicals the bonds are much weaker than in the stable compounds. [See Abstract 4087 (1939).] AUTHOR.

494. Potential-energy relationships in normal and excited acetaldehyde. T. W. DAVIS AND M. BURTON. *J. Chem. Phys.*, **7**, *pp.* 1075–1080, *Dec.*, 1939.—By a simple modification and extension of the system of potential-energy hypersurfaces used to correlate the observations in the thermal and the photochemical decomposition of acetaldehyde it is shown that the following effects are explained: (1) the dependence on temperature and wave-length of relative probabilities of free-radical and ultimate molecule production in the primary photochemical act; (2) the disappearance of fluorescence at shorter wave-lengths or at higher temperatures; (3) the separate maxima for band and continuous absorption; (4) the high quantum yield reported at 3 340 Å. AUTHORS.

495. Chain length and chain-ending processes in acetaldehyde decomposition. M. BURTON, H. A. TAYLOR AND T. W. DAVIS. *J. Chem. Phys.*, **7**, *pp.* 1080–1085, *Dec.*, 1939.—The C–C bond strength in acetaldehyde is probably less than a previously postulated value of 93 kg. cal. and may be as low as the 75 kg. cal. value calculated by Grahame. The chain-ending processes in the pyrolysis, in the azomethane-induced decomposition, and in the photolysis of acetaldehyde are all bimolecular but it is clear that the processes in the second and the third decompositions cannot be identical. The uncertainty of the process in the pyrolysis introduces an uncertainty into Grahame's calculation. In any event, the process is not the combination of methyl radicals in the gas phase to yield ethane. In the photolysis (and perhaps in the pyrolysis) HCO seems to be involved in the chain-ending reaction. In the induced decomposition CH_3CO seems to be concerned. The recombination of methyl radicals as a wall reaction may occur in packed vessels. Activation energies of the various reactions are discussed. AUTHORS.

496. Measurement of deflagration velocity. R. ZOUCKERMANN, L. HEYBERGER. *Comptes Rendus*, **209,** *pp.* 680–682, *Nov.* 6, 1939.—The velocity of propagation of deflagrations was measured even when the flame was not sufficiently luminous to affect the eye or a photographic plate. The gaseous mixture was placed within a tube of glass or iron of at least 200 cm. length and of 2 to 5 cm. dia. Bolometers made of some centimetres of a fine Ni wire were stretched along the tube and placed in series in a branch of a Wheatstone's bridge. A diagonal of the bridge was connected to an a.c. source of 500 V current, modulated to 50 periods, and the other diagonal was connected to a registering oscillograph. The tube could be connected to a vacuum pump or to a reservoir containing the gaseous mixture to be tested. Deflagration of the mixture was caused by a spark from an induction coil. By this method a saturated mixture of H and O was tested and the results are given in a table. They show: (1) the maximum content of H_2 is sensibly independent of the dia. of the tube; (2) the velocity of propagation in the neighbourhood of the minimum content increases with the content of H_2 and with the section of the tube. J. J. S.

See also Abstracts 295, 461.

THERMODYNAMICS.

497. Critical and co-operative phenomena. Part V. Specific heats of solids and liquids. A. F. DEVONSHIRE. *Roy. Soc., Proc. A*, **174,** *pp.* 102–109, *Jan.* 12, 1940.—Specific heats of simple substances in the liquid or solid phase have been calculated in terms of the intermolecular forces. Comparison is made with the experimental values for Kr and A, and fair agreement is obtained. Calculations are also made of thermal expansion and compressibility. [For Part IV see Abstract 2949 (1939).] AUTHOR.

498. Kinetics of phase change. Part I. General theory. M. AVRAMI. *J. Chem. Phys.*, **7,** *pp.* 1103–1112, *Dec.*, 1939.—The theory of the kinetics of phase change is developed with the experimentally supported assumptions that the new phase is nucleated by *germ nuclei* which already exist in the old phase, and whose number can be altered by previous treatment. The density of germ nuclei diminishes through activation of some of them to become *growth nuclei* for grains of the new phase, and ingestion of others by these growing grains. The quantitative relations between the density of germ nuclei, growth nuclei, and transformed volume are derived and expressed in terms of a *characteristic time scale* for any given substance and process. The geometry and kinetics of a crystal aggregate are studied from this point of view, and it is shown that there is strong evidence of the existence, for any given substance, of an *isokinetic* range of temperatures and concentrations in which the characteristic kinetics of phase change remains the same. The determination of phase reaction kinetics is shown to depend upon the solution of a functional equation of a certain type. Some of the general properties of temperature-time and transformation-time curves, respectively, are described and explained. AUTHOR.

499. Inversion of partition function to determine density of energy states. S. H. BAUER. *J. Chem. Phys*, **7,** *pp.* 1097–1102, *Dec.*, 1939.—The density of energy states for a complex system may be deduced from thermodynamic functions when their dependence on temperature is specified. The method is general and depends for its accuracy on the closeness of approximation of the experimentally determined partition function by an appropriate equation. Accurate specific heat data are therefore essential. The degeneracy function is obtained by inverting the Laplace integral defining the sum-over-states; as illustrations, the energy states for an Einstein crystal, and for a modified Debye crystal without and with a transition are discussed. The author was not successful in finding a mathematical expression which fitted the last case sufficiently well to differentiate between transitions of first and higher order. AUTHOR.

500. Quantum-mechanical basis of statistical mechanics. E. C. KEMBLE. *Phys. Rev.*, **56,** *pp.* 1146–1164, *Dec.* 1, 1939.—Von Neumann's macroscopic entropy definition is not wholly satisfactory because (*a*) it rests on an unsatisfactory characterization of macroscopic variables, (*b*) it fails to make satisfactory connection with the Nernst heat theorem, (*c*) it is based on an unsatisfactory definition of thermal equilibrium, (*d*) it is not applicable to microscopic systems. It is proved that if two systems initially in independent states are placed in thermal contact and isolated, the sum of their microscopic entropies cannot decrease, but will in general increase. This theorem is a substitute for the usual rule regarding the increase in entropy of a single isolated system. Appreciable departures from the canonical state are shown to have a vanishingly small probability in the case of a system subjected to the thermostat experimental procedure described in a preceding paper. [See Abstract 202 (1940).] AUTHOR.

See also Abstracts 309, 315, 316, 357, 520.

VAPORIZATION AND CONDENSATION.

501. Boiling points of formic-acid/water system. S. TAKAGI. *Chem. Soc., Japan, Bull.*, **14,** *pp.* 508–509, *Nov.*, 1939.—Boiling points of the liquid and the compositions of the liquid and the vapour phase in equilibrium in the system of formic acid and water were determined over a wide range of composition and temperature, and from the data the equation for the vapour pressure at the azeotropic point was determined. AUTHOR.

***502. Saturated vapour pressure of Li between 462°C. and 642°C.** M. MAUCHERAT. *J. de Physique et le Radium*, **10,** *pp.* 441–444, *Oct.*, 1939.—The saturated vapour pressure of Li has been determined by a modification of Bogros' method, in which the vapour from heated Li is made to impinge and condense on a cooled plate, after it has passed through two orifices. The apparatus is fully illustrated and described, and the method of calculating the results is given. The Li deposited is allowed to react with water and is then titrated with H_2SO_4. The final result for the variation of the vapour pressure with temperature is $\log_{10}P_{mm.} = 8\cdot012 - 8\cdot172/T$, and this is compared with other results. A value of 36 600 cal./atm./gm. for the latent heat of vaporization of Li at approximately 550°C. is calculated from the Clapeyron equation. E. H. D.

503. Vapour pressure of oleum. F. D. MILES, H. NIBLOCK AND G. L. WILSON. *Faraday Soc., Trans.*, **36**, *pp.* 345–356, *Feb.*, 1940.—The vapour pressures of oleum have been determined over a field which is limited generally by a concentration of 65% free trioxide, and a pressure of 950 mm. and at particular points by a temperature of 170°C. The results agree with none of the published sets of oleum vapour pressures, but nevertheless appear to be reliable, and are in agreement with indirect estimates of the vapour pressure from certain other data. Some peculiar features of the vapour pressure curves are discussed. The vapour pressures of SO_3 have been redetermined from 17° to 62°C. AUTHORS.

504. Partial pressures of nitric acid-water mixtures from 0°–20° C. G. L. WILSON AND F. D. MILES. *Faraday Soc., Trans.*, **36**, *pp.* 356–363, *Feb.*, 1940.—The partial vapour pressures of HNO_3 and water over HNO_3 water mixtures have been determined in a special apparatus over the range of compositions from 50% to 100% HNO_3, at 20° and 0°. The values at intermediate temperatures have been calculated from these. The heats of dilution of HNO_3 (50–100%) have been determined and a new value (much higher than the only available one due to Berthelot) has been obtained for the heat of vaporization of pure HNO_3. AUTHORS.

See also Abstracts 317, 489.

ACOUSTICS.

505. Intense combination tones produced by flutter of airscrew. J. OBATA AND Y. YOSIDA. *Phys. Math. Soc. Japan, Proc.*, **21**, *pp.* 588–593, *Oct.*, 1939.—The intense sound emitted by an airscrew when flutter occurs, consists, in addition to the sounds of rotation (fundamental tone and several harmonics) and torsional vibration of the blade, of a large number of combinational tones which are formed by these two different kinds of sounds. These intense combinational tones are very remarkable as a novel example of combinational tones actually existing in the air. Their origin may be due to the same mass of air being violently agitated simultaneously by the intense pressure difference between the front and back of the airscrew blade and the violent torsional vibration of the blade. AUTHORS.

506. Supersonic analogy of electromagnetic field. D. RIABOUCHINSKY. *Comptes Rendus*, **209**, *pp.* 587–589, *Oct.* 16, 1939.—Corrects and amplifies a previous note on this subject. [See Abstract 364 (1939).] W. S. S.

***507. Supersonic method for testing homogeneity of solids.** A. GIACOMINI AND A. BERTINI. *Ricerca Scientifica*, **10**, *pp.* 921–925, *Oct.*, 1939.—An attempt has been made to put into practice the use of supersonic waves instead of X-rays for the examination of the homogeneity of solid matter. The main problem to be solved was that of the examination of the beam after it had passed through the solid. Two methods are available—firstly an electric one by means of piezoelectric quartz crystals and secondly a more direct examination of the sound wave itself by making it visible by the Bär-Parthasarathy-Hiedemann method. An apparatus is described for this purpose. It consists of a generator of the supersonic waves, which pass along the axis of a cylindrical holder of the solid, and an apparatus for the examination of the visible striations produced by the emergent sound waves. These can be photographed and 2 such photographs are reproduced. A discussion of the conclusions to be drawn from such photographs follows. Various modifications of the apparatus are also described. G. G.

***508. Fixed-path acoustic interferometer for study of matter.** J. C. Hubbard and I. F. Zartman. *Rev. Sci. Instruments*, **10**, *pp*. 382–386, *Dec*., 1939.—The resources of supersonic interferometry have been extended by the development of an interferometer of fixed path. In this device a fixed distance is maintained between a piezoelectric resonator and a reflector. Variation of acoustic reaction of the medium between them is secured by a variation of the acoustic wave-length produced by changes of temperature, pressure or composition, or in liquids and solids by a change in frequency. It is particularly adaptable to the study of the velocity of sound in gases from the lowest temperatures attainable to approximately 500°C. and over a pressure range of at least 100 atm. because of the elimination of moving parts and packed joints. The method is also applicable, when results are obtained with two precisely known lengths of path, to the measurement of acoustic absorption and reflection coefficients. Results obtained with air and CO_2 are given. Authors.

***509. Stethoscope of variable sensibility and selectivity.** H. J. Frossard. *Comptes Rendus*, **209**, *pp*. 728–730, *Nov*. 13, 1939.—Description of a stethoscope which, by means of a valve, which can be regulated, eliminates the low notes which are not required for notice. The intensity of the train of waves is diminished, and the suppression of the low sounds follows. J. J. S.

See also Abstract 340.

ELECTRICITY AND MAGNETISM.

ALTERNATING-CURRENT NETWORKS.

510. Matrix theory of oscillatory networks. L. A. Pipes. *J. of Applied Physics*, **10**, *pp*. 849–860, *Dec*., 1939.—Starting with the energy functions of a general, linear, bilateral, resistanceless, lumped network the canonical equations of the circuit are obtained. These equations are solved in a general form taking into account applied electromotive forces and initial charges and currents by a matrix multiplication process. It is shown how the matrix multiplication process replaces the usual " frequency equation " which determines the normal modes of the system. Initial charges and currents in the various component parts of the network are considered for generality. The method given appears to have some computational advantages in certain classes of problems over the method of the " Heaviside calculus". The discussion is concluded with a discussion of normal co-ordinates and an illustrative numerical example is given. Since oscillatory networks are used extensively in communication engineering it is hoped that the present discussion will be of value. Since, if the circuit has a small amount of resistance present it may be shown that periods of oscillation are affected only by the squares of small quantities, it is seen that the method given is applicable to many technical problems. A method is given by which the attentuation due to the presence of small resistances in the system may be readily calculated. AUTHOR.

511. Method of symmetrical components applied to harmonic analysis. L. A. PIPES. *Phil. Mag.*, **29,** *pp.* 66–74, *Jan.*, 1940.—A method of determining the Fourier series coefficients from a graphically known wave is presented. The special feature of this method is the use of Fortescue's sequence operator S_m, which plays such a prominent rôle in the theory of symmetrical components [see Abstract 661B (1918)]. The determination of the various coefficients is then reduced to a simple matrix multiplication scheme involving the sequence operators S_m and a columnar matrix [*u*] formed from the ordinates of the graphically known wave. AUTHOR.

***512. Balancing an impedance bridge.** G. B. HOADLEY. *Frank. Inst., J.*, **228,** *pp.* 733–754, *Dec.*, 1939.—Usually the operator of an impedance bridge has little or no idea of the actual process by which the detector voltage is brought to zero. By drawing locus diagrams for the bridge, the process of attaining balance is interpreted in a graphical manner, which helps in the design and operation of the bridge. The diagrams show where to set the adjustments initially to get good sensitivity, and with which adjustment to start. Trivial balances, where the adjustments approach zero or infinity, are explained by the diagrams. Shifting balances, in which many adjustments are needed in order to approach balance, are shown to be present when the loci for the different adjustments intersect each other at angles less than about 45°. The actual intersection angle can be obtained from the results of two partial differentiations of the balance equation, without the construction of the loci. From this angle, the rapidity of attaining balance can be found. Furthermore, it is shown that more rapid balance is obtained, especially with small intercept angles, if the adjustments are purposely overshot. Unfortunately there seems to be a slight natural tendency toward undershooting.

AUTHOR.

See also Abstract

51B. Oscillographic technique for measurements in a network analyzer. D. M. Myers and W. K. Clothier.

CONDUCTION AND DISCHARGE IN GASES.

513. Interpretation of ionization measurements in gases at high pressures. E. KARA-MICHAILOVA AND D. E. LEA. *Cambridge Phil. Soc., Proc.*, **36,** *pp.* 101–126, *Jan.*, 1940.—When γ-radiation passes through a gas it ionizes by means of fast electrons which produce clusters of secondary ionization at intervals along their paths. At high pressures a considerable amount of recombination of ions takes place in these clusters ; in the present paper a theory is described which enables the proportion of ions escaping recombination to be calculated as a function of the gas pressure and collecting field. A review of the available experimental data concerning the variation of ionization current with pressure and collecting field is given, and it is shown that the predictions of the cluster recombination theory are in satisfactory agreement with these experimental data. Jaffé has given a theory of initial recombination valid for a columnar distribution of ionization, and has shown that this theory is in agreement with experiments in which α-particles produce the ionization. A number of authors have applied Jaffé's equations to ionization produced by fast electrons regardless of the initial localization of the ions in clusters. It is shown in the present paper that such measure of agreement with experiment as is obtained by this procedure is only obtained at the expense of assigning incorrect values to certain known constants. Also in the case of X- and γ-rays the columnar theory predicts a variation of the proportion of recombination with the wavelength of the radiation which is much too rapid. It is further shown that the method based on Jaffé's equations which is used by Clay and his colleagues to extrapolate experimental ionization currents at finite collecting fields to saturation currents at infinite fields is liable to systematic error in a direction likely to lead to the deduction of a spurious wall effect or the exaggeration of an existing wall effect. AUTHORS.

514. Atom-physical interpretation of Lichtenberg figures and their application to the study of gas discharge phenomena. F. H. MERRILL AND A. v. HIPPEL. *J. of Applied Physics*, **10,** *pp.* 873–887, *Dec.*, 1939.—The extremely finely detailed drawing in Lichtenberg figures offers an unusally clear record of the early stages of discharge phenomena. The interpretation of these records in terms of electronic ionization, space charge, plasma formation, and neutralization of charges is presented in this paper. After giving a short summary of our present knowledge about gas breakdown, the " normal " history of a Lichtenberg discharge is established by a study in N_2 between 5 mm. of Hg and 30 atm. of pressure. It progresses in three stages—the primary figure, spark development, and the discharge of negative surface charges. (The " back figure.") Admixture of CCl_4 and experiments in " Freon " up to 6 atm. show the decisive influence of electro-negative components on the development of the phenomena, and reveal the reasons why these new gases are so effective in suppressing corona discharges. Deviations from Paschen's law, recently observed by several workers, can be interpreted in terms of the photographic evidence gained. AUTHORS.

515. Plasma state of gases. R. ROMPE AND M. STEENBECK. *Ergeb. d. exakt. Naturwiss*, **18,** *pp.* 257–376, 1939.—The scope of this comprehensive description of the typical properties of gas plasma is indicated by the following major headings under which the subject matter is presented: Experimental methods; energy exchange between plasma partners; electrical conductivity of plasma in static fields; mean decrease of ionization potential in plasma; plasma oscillations; dielectric and magnetic properties of plasma; consideration of properties of individual atoms; isothermal plasma; non-isothermal plasma. A list is given of 579 references to original papers bearing on this subject. J. E. K.

516. Excitation of inner electrons in Zn, Cd and Hg by electron impact. A. H. LEE. *Roy. Soc., Proc. A*, **173,** *pp.* 569–580, *Dec.* 29, 1939.—Certain analogous ultra-ionization potentials have been observed in Zn, Cd and Hg, while studying the energy losses of electrons in the vapours of these elements. In order to explain these " U.I.P.'s," all the processes which could give rise to them are examined in detail. It appears that none of the processes which were formerly found to be responsible for such effects is adequate in the present case. A new process—excitation of an inner electron—hitherto unrecognized in electron impact experiments, is shown to be the cause. The analogous U.I.P.'s correspond to analogous transitions observed by Beutler in the u.v. absorption spectra of the three elements, and attributed by him to excitation of a *d* electron in the closed shell immediately below the valence shell, resulting in a $^3P_1$ state, in each case. (The valence electrons remain in their normal states.) A further

U.I.P. in Hg is explained in a similar way. The observed U.I.P.'s are abnormally intense for ${}^1S_0$–${}^3P_1$ excitations at the bombarding voltages used. This anomaly may be a consequence of the unusual process involved. Hence an approximate determination of the excitation function of the first " inner " excitation in Hg has been made, and certain features noted. AUTHOR.

517. Inner-shell ionization of atoms by electron impact. E. H. S. BURHOP. *Cambridge Phil. Soc., Proc.*, **36,** *pp.* 43–49, *Jan.*, 1940.—Calculations have been made of the cross-section for ionization of the inner shells of atoms by electron impact in the cases of the K-shells of Ni, Ag, Hg and of the three L-shells of Ag and Hg. The agreement with experiment is reasonably good for the K-shell ionization, but only fair in the case of the rather meagre experimental data available for the L-shell. The values obtained for the relative ionization in the K- and L-shells are in good agreement with those to be expected from experiment. [In an *Appendix, ibid.* (*pp.* 50–52), **H. S. W. Massey** discusses the normalization of screened continuous wave functions.] AUTHOR.

518. Townsend ionization co-efficients for Ni and Al cathodes in an atmosphere of hydrogen. D. H. HALE. *Phys. Rev.*, **56,** *pp.* 1199–1202, *Dec.* 15, 1939.—Measurements of the first and second Townsend co-efficients for ionization by collision have been carried out for surfaces of Ni and Al in an atmosphere of H_2. The Al surface was evaporated in an atmosphere of A and is estimated to be a few hundred molecular layers thicks. The values found for the α- and γ-co-efficients are compared with the results previously reported for a Pt surface in H_2 [see Abstract 2975 (1939)]. The values of α/p, in pure H_2 plotted as a function of X/p show a decreasing characteristic between values of X/p from 900 to 1 400. The curves of values of γ plotted as a function of X/p show a characteristic photo-emission peak at an X/p of 131, and a gradual rise at the higher values of X/p. Sparking potential curves are calculated from the γ-values and are compared with the experimentally determined curves. AUTHOR.

See also Abstracts 340, 423, 424, 430, 456, 567, and

38B. Electric strength of gases, measured by corona discharge. W. M. Thornton.

139B. Behaviour of high-intensity mercury arcs falling freely under gravity. C. Kenty.

CONDUCTION IN SOLIDS AND LIQUIDS.

***519. Duo-triode bridge voltmeter.** R. E. VOLLRATH. *Rev. Sci. Instruments*, **10,** *pp.* 361–362, *Dec.*, 1939.—A bridge voltmeter is described in which a duo-triode is used in place of two separate triodes with a resulting gain in simplicity and compactness. AUTHOR.

520. Change in resistance of alkali metals on melting. A. HARASIMA. *Phys. Math. Soc. Japan, Proc.*, **21,** *pp.* 679–686, *Nov.*, 1939.—Using the concept on the process of melting [see Abstract 4084 (1939)], the change in electrical resistance of alkali metals on melting is calculated by comparing the mean square deviations of atoms, which are taken to be proportional to the electrical resistance, in the solid and in the liquid. The calculated values of R_l/R_s (R_l and R_s are electrical resistances of the liquid and the solid respectively) agree well with observed values. Temperature co-efficient of resistance of the liquids is also calculated, giving a result of the right order of magnitude. Finally, the relation of the present theory to that of Wigner and Seitz is discussed.

521. Properties of some superconductors. D. Shoenberg. *Cambridge Phil. Soc., Proc.*, **36**, *pp.* 84–93, *Jan.*, 1940.—The critical-field curves of pure Al, Ga, Th and Zn were measured by a magnetic induction method. An unusually marked supercooling effect was found in Al and to a much smaller extent also in Ga ; some experiments on this effect are discussed. The first three of these metals were found to have " ideally pure " superconducting properties, and Th, although belonging to the " hard " group of superconductors, had a value of dH_c/dT of only 190 gauss/deg. K. Only a very minute fraction of the volume of a Ti specimen was found to become superconducting at temperatures down to 1°K., although Meissner had found a Ti wire to have zero resistance below 1·8°K. ; an explanation of this discrepancy is put forward. Mo and U did not become superconducting down to 0·3 and 0·98°K. respectively, though in the case of one U sample, a small fraction of the volume showed superconducting effects as in Ti. Author.

522. Electrical conductivity and thermo-electric power of αAg_2S. H. Reinhold and K. Schmitt. *Zeits. f. phys. Chem. Abt. B*, **44**, 2, *pp.* 75–108, 1939.—The effect of the pressure of S and the temperature on the electrical conductivity of α-Ag_2S in the form of wire has been investigated. The empirical equations governing these effects are $\chi_T = Ae^{-B/T}$, for constant temperature of Ag_2S (T = temperature of S vapour, A and B are constants), and $\chi_p = A'e^{-B'/T_1}$ for constant pressure of S vapour (T_1 is temperature of Ag_2S, A' and B' are constants). The dependence of the amount of excess S in the compound on the pressure of S and temperature was also investigated, and the thermo-electric power of the junction Pt — α-Ag_2S was determined for a number of different pressures of S. The results are discussed. Investigation of the connection between conductivity and thermo-electric power shows that the conductivity is proportional to the electron concentration. The electrical conductivity of Ag_2S in S vapour depends on the dimensions of the vessel in which the determination is carried out. This is shown to be due to dissociation and recombination of S molecules, the velocity of which is comparatively low. A streaming method is described by which both velocities can be determined by conductivity measurements. The dissociation is of the first order, and the half-value time is of the order of 1 min. A. J. M.

See also Abstracts 300, 483, 490, 574, 575, 576, and

52B. Direct-reading vacuum-tube millivoltmeter. W. Lyons and R. E. Heller.

DIELECTRICS AND CAPACITANCE.

523. E.H.F. dielectric constants of NH_3, N_2 and CO_2. G. W. Fox and A. H. Ryan. *Phys. Rev.*, **56**, *pp.* 1132–1136, *Dec.* 1, 1939.—The heterodyne beat method has been used to determine the dielectric constants of N_2, CO_2 and NH_3 at a frequency of 56 Mc./s. in the temperature range of 22°C. to 45°C. The method proved to be entirely satisfactory showing that the techniques customarily applied in making measurements at the lower frequencies are applicable in the ultra-high frequencies as well. The dielectric constants of N_2 and NH_3 at 56 Mc./s. agree with the values found at low frequencies. In the case of CO_2, an anomaly was observed, the value of the constant rising from its normal value to a maximum at about 39°C. and then decreasing. This variation is briefly discussed.
Authors.

524. Polar structure of benzein indicators. M. A. Elliott and S. F. Acree. *Bureau of Standards, J. of Research*, **23**, *pp*. 675–681, *Dec*., 1939.—In the study of electronic effects associated with changes of colour of indicators, the approximate electric moments have been measured for α-naptholbenzein and thymolbenzein in benzene solution. The values obtained were $4 \cdot 3 \times 10^{-18}$ and $6 \cdot 8 \times 10^{-18}$ e.s.u. respectively. These values are much lower than those predicted for the benzein type of molecule on the basis of the static dipolar structure. They are compatible, however, with the quinone-phenolate resonance theory and indicate that these molecules are predominantly in the structure shown in figure 1 of the original, with very little of the resonant dipolar form. Authors.

525. Internal rotation and dipole moment in succinonitrile. G. L. Lewis and C. P. Smyth. *J. Chem. Phys*., **7**, *pp*. 1085–1093, *Dec*., 1939.—A new heterodyne-beat apparatus has been employed to determine the dipole moment of acetonitrile from − 60° to + 60° and that of succinonitrile from − 90° to + 90° in solution. By assuming each half of the succinonitrile molecule to have the same moment as the acetonitrile molecule, the observed moments have been used to calculate the height of the potential barrier which restricts rotation around the C-C single bond in succinonitrile and thereby causes the moment of the molecule to increase with rising temperature. The value $1 \cdot 2 \pm 0 \cdot 5$ kg.cal. thus obtained is in better agreement with the value $1 \cdot 5$ obtained from the calculation of the sum of the various potential energies existing between the two halves of the molecule than is warranted by the necessarily approximate nature of the calculation. Authors.

526. Zwitterion-structures in unsaturated carbonyl compounds. A. Weizmann. *Faraday Soc., Trans*., **36**, *pp*. 329–333, *Feb*., 1940.—The occurrence of zwitterion-structure is detected in compounds of the *p*-dimethyl-amido-benzaldehyde, *p*-dimethylamido-benzal-acetophenone and ethyl *p*-amino-benzoate type by means of dipole-moment measurements. The difference in electric moment of two isomeric dimethyl-amido-cinnamylidene-acetones obtained is discussed. Author.

527. Torsional flexibility of aliphatic chain molecules. A. Müller. *Roy. Soc., Proc. A*, **174**, *pp*. 137–144, *Jan*. 12, 1940.—A series of measurements is made of the dielectric polarization of two diketones. The two substances consist of aliphatic chain molecules each carrying two C—O dipoles. These two dipoles are differently situated in the two substances. In one substance, $C_{10}H_{18}O_2$, the two dipoles are antiparallel and tend to neutralize each other; in the other, $C_{11}H_{20}O_2$, they are on the same side of the chain axis and therefore reinforce each other. From the behaviour of the two substances in the neighbourhood of their melting-points it is concluded that even comparatively short chains suffer considerable distortion under the influence of temperature. Estimates from other observations support this conclusion. Author.

528. Dielectric investigations on heavy Rochelle salt. J. Hablützel. *Helv. Phys. Acta*, **12**, 6, *pp*. 489–510, 1939. *In German*.—Rochelle salt crystals exhibit anomalous dielectric peculiarities and therefore have recently been the object of numerous investigations. The dielectric behaviour of the salt is largely analogous to the magnetic behaviour of ferromagnetic substances with the important difference that dielectric saturation and hysteresis only appear in a crystallographic principal axis and disappear not only with high but also with low temperatures. Two Curie points exist in the substance. There is much experimental material available and it has been sought to develop a unitary molecular theory of the electrical behaviour of Rochelle salt. In the present paper many previous investigations are referred to and the author has examined the electrical behaviour of the crystals, in the direction of the chief axis, as to their dependence on temperature, field strength and frequency. The crystals of the heavy salt are easily obtained from Rochelle salt ($KNaC_4H_2D_2O_6$, $4D_2O$) fully deprived of water in 99·6% D_2O. Diagrams are given showing the hysteresis curves at various temperatures. The results, indicating the important differences between the behaviour of light and heavy Rochelle salt, suggest that the H atom is of decisive influence in causing the anomalies. Experiments using X-ray analysis with KH_2PO_4, and also isotope effects support this view. For the explanation of the behaviour of the salt at low temperatures it must be assumed that the rotation of the H nucleus round the central O–O is influenced by lattice forces. J. J. S.

529. H.F. dielectric losses in liquids. Part V. P. WULFF, H. SCHWINDT AND S. TAKASHIMA. **Part VI.** P. WULFF AND S. TAKASHIMA. *Zeits. f. phys. Chem. Abt.B*, **39**, 5–6, *pp.* 315–351, 1938.—In Part V a condenser for measurements of the dielectric constant and power factor of liquids is described, consisting of two concentric cylindrical vessels of quartz. Pt foil which is firmly attached to the inside surface of the outer cylinder and the outer surface of the inner cylinder, serves as the electrode material. Part VI describes measurements of the dielectric properties of polar liquids in non-polar solvents. It is found that there are no losses due to dipole orientation in phenol-benzene solutions. In solutions of cyclohexanol in benzene, cyclohexane and decalin, dipole losses are observed. The calculated values of the dipole radius and the molecular polarisation are not constant with differing concentrations of cyclohexanol, but appear to pass through a maximum as the cyclohexanol content is increased. It is deduced that these maxima are due to polar association effects in accordance with Debye's conception of a quasi-crystalline structure of liquids, and that increasing concentration of the polar liquid leads to a reduction in polar association. [For Parts III and IV see Abstract 2577 (1938).] E. R.

See also Abstracts 300, 536, and

40B. Equipment for testing electric insulation materials. H. I. Morgan.
56B. Measurement of dielectric loss at frequencies of 10 to 50 Mc./s.

ELECTROCHEMISTRY.

530. Piezo-electric investigation of mechanism of lead accumulator. E. COHEN and G. W. R. OBERDIJKINK. *K. Ned. Akad. Wet., Proc.*, **42**, 9, *pp.* 834–848, 1939. *In German.*—If the equation $2PbSO_4 + 2H_2O \rightleftharpoons Pb + PbO_2 + 2H_2SO_4$ (reversible) is correct $E = W/nF + T(dW/dT)$. Dolezalek has confirmed this, but since the experimental difficulties are great, the authors prefer the Gibbs relation $(dE/dp) = -\Delta V/nF$ for experimental investigation. For passage of $2F$ coulombs $\Delta V = -V_1 - V_2 - 2V_3 + 2V_4 + 2V_5 = -V_1 - V_2 - 2M[v_e + (1-c)(dv_e/dc)] + 2V_4 + 2M'[v_e - c(dv_e/dc)]$. Values for Pb, PbO_2 $PbSO_4$, 27·32 H_2SO_4, and paraffin oil, are critically considered and redetermined where necessary, the following being adopted finally :—$V_1 = 18{\cdot}126 \pm 0{\cdot}026$, $V_2 = 24{\cdot}871 \pm 0{\cdot}018$, $2V_4 = 95{\cdot}330 \pm 0{\cdot}050$, $v_e = 1{\cdot}000\,235 + 0{\cdot}711\,25\,c + 0{\cdot}271\,2\,c^2$, $(dv_e/dc) = -0{\cdot}563\,17$. From these data $(dE/dP) = 3{\cdot}09 \pm 0{\cdot}031 \times 10^{-6}$ V/atm. at N.T.P. Experimental determinations between 1 and 1 000 atm. give 3·05 and 3·09 × 10^{-6} for rising and falling pressure respectively. Since both calculated and observed values depend on the summation or measurement of small differences, the agreement is held to be very satisfactory, again confirming the double sulphate theory. D. R. H.

531. Cathode phenomena in electrolysis of alkali electrolytes. R. Piontelli. *Gazz. Chim. Ital.*, **69,** *pp.* 221–237, *April,* 1939.—The author discusses critically, from the point of view of energy transfer, various mechanisms suggested for evolution of cathodic H_2 from baths containing alkali ions, under the heads—(1) General. Arhennius' hypothesis. (2) Le Blanc's hypothesis. $H_2O \rightleftharpoons H^{\cdot}_{aq} + OH'_{aq}$, $H^{\cdot}_{aq} + \Theta \rightarrow \frac{1}{2}H_2$. (3) General considerations of energy involved in (*a*) extraction of ions from the cathode, (*b*) dehydration of a cation, (*c*) neutralization, (*d*) passage from the absorbed state of the cathode surface, (*e*)synthesis, (*f*) liberation of molecules, (*g*) gaseous phase formation. From a discussion of $J + \Lambda - H$ it appears that in the series $Na^{\cdot}$, $K^{\cdot}$, $Cs^{\cdot}$, $Ag^{\cdot}$, the potential energy of the system hydrated ion/polarized electrode passes through a maximum. (4) Application to alkaline solutions. Depolarization depends on (*a*) concentration in the double layer, (*b*) resistance to solid phase formation, analogous to energy of alloying or absorption or sublimation. (5) Discharge of $H^{\cdot}$ ions as a protolytic process. He concludes that the classical conception of discharge of alkali cations (i.e. formation of highly unstable alloys) is valid only for Hg and Pb cathodes. In general, H_2 is derived from solvated cations playing a part analogous to proton-donor or -acceptor. The products form a double layer, with NaOH (Arrhenius) or $Na(H_2)_{n-1}OH$ (Le Blanc) diffusing outwards and being replaced by hydrated ions. Similar concepts can be applied to O_2 evolution from salts of oxy-acids and to electrolysis of mixed solutions. A useful bibliography of 35 references is included. D. R. H.

532. Application of theory of absolute reaction rates to overvoltage. H. Eyring, S. Glasstone and K. J. Laidler. *J. Chem. Phys.*, **7,** *pp.* 1053–1065, *Nov.*, 1939.—It is shown by the theory of absolute reaction rates that the current density I at an electrode is related to the overvoltage V by the expression $I = I_0 e^{\alpha VF/RT}$, where I_0 is a constant for a given electrode, representing the current passing in each direction at the reversible potential, and α is the fraction of the added potential V operating between the initial and activated states. I_0 can be expressed in terms of a number of determinable quantities and constants, and the characteristics found for these quantities indicate that the process of discharge of a H-ion involves the transfer of a proton from a H_2O molecule attached to the solution to another H_2O molecule attached to the electrode surface. The suggested mechanism accords with a symmetrical barrier at the electrode surface, the linear rate of attainment of overvoltage, and the effect of changes in ζ-potential and it is shown that metals which form strong M-H bonds should have low overvoltage, as found. The H-D electrolytic separation factor is considered from the standpoint of the prototropic theory of overvoltage, and an explanation is proposed for the influence of cathode material and of temperature. Oxygen overvoltage is attributed to a proton transfer in the opposite direction, i.e. from a H_2O molecule on the electrode to one in a layer associated with the solvent. The fact that H_3O^+ and OH^- ions are built into the structure of the solvent water explains the high overvoltage accompanying their discharge. N. M. B.

*533. **Potentiometric method for accurate measurement of H-ion activity.** W. J. HAMER AND S. F. ACREE. *Bureau of Standards, J. of Research,* **23,** *pp.* 647–662, *Dec.,* **1939.**—A potentiometric method is described for measurements of H-ion activities in aqueous solutions. Galvanic cells without liquid junctions are used. In this method H_2 and Ag/AgCl electrodes are placed in solutions to which known amounts of either NaCl or KCl have been added. A detailed description is given of the equipment and experimental procedures which are necessary for precise measurements of H-ion activities. The e.m.f. of the galvanic cell, on the average, is reproducible to 0·02 mV which is equivalent to 0·0003 *p*H unit. It is found that the electrodes function reversibly and exhibit no ageing, hysteresis, or polarization effects. It is shown how the H-ion activity may be calculated from the e.m.f. by thermodynamic methods, using the Nernst equation, in which the concepts of activity and interionic attraction are incorporated. AUTHORS.

534. Amperometric (polarometric) titration of lead with dichromate or chromate. I. M. KOLTHOFF AND YU-DJAI PAN. *Am. Chem. Soc., J.,* **61,** *pp.* 3402–3409, *Dec.,* 1939.—The word "amperometric titration" is coined and the historical development of this type of titration is discussed. Pb can be titrated accurately, precisely and rapidly by amperometric titration with dichromate or chromate, using the dropping Hg electrode as an indicator electrode. The titration can be carried out without applying an external e.m.f. Even 0·001*M* Pb solutions can be titrated with a high degree of accuracy. Pb can be titrated amperometrically in the presence of large amounts of Ba when the solution is slightly acid with $HClO_4$. The fractional precipitation of Pb and Ba in neutral medium with K_2CrO_4 does not yield good results due to coprecipitation of $BaCrO_4$ with $PbCrO_4$. AUTHORS.

535. Electrode polarization. Part II. Rate of growth of polarization potentials. A. HICKLING. *Faraday Soc., Trans.,* **36,** *pp.* 364–369, *Feb.,* 1940. —A new method of studying the rate of growth of polarization potentials is described which gives a stationary image on the screen of a cathode-ray oscillograph showing directly the variation of potential with quantity of electricity passed. The method has been tested by applying it to the study of the growth of H_2 overvoltage at a Hg surface, and results in general conformity with those of previous workers have been obtained. The growth of overvoltage in the deposition of Ni has been studied, and it is found that the potential varies linearly with quantity of electricity passed, up to the point at which separation of metal begins. The results support the view that this type of polarization is due to slowness of the discharge of the metallic ions. [For Part I see Abstract 329 (1938).] AUTHOR.

536. Electrical equilibrium in electrolytes. D. CASTELLUCCIO. *N. Cimento,* **16,** *pp.* 348–354, *July,* 1939.—Assuming that an electrolyte behaves as a perfect gas, a general equation is deduced expressing the conditions of electrical equilibrium in terms of the (unknown) distribution of charged bodies. A particular case that can be solved gives the standard equation of chemical equilibrium. An approximation in another special case gives the capacitance of an electrolytic condenser bounded by plane electrodes as $C=(\epsilon S/4\pi 2l)\,(al/\tanh al)$ where ϵ is the dielectric constant of the solvent, S and $2l$ are the area and separation of the electrodes, and $a^2=(8\,\pi\alpha\eta Nq^2)/(\epsilon KT)$, where η is the molar concentration, α is the degree of dissociation, q the charge of the electron, and N Avogadro's number. For a normal solution of NaCl in water at 18°C. $a = 2{\cdot}82 \times 10^7$ cm^{-1}. and for pure water $a = 9{\cdot}1 \times 10^3$ cm^{-1}. W. H. W.

See also Abstracts 319, 524.

ELECTRONS, NEUTRONS, POSITRONS AND PROTONS.

537. Classical theory of electrons. H. J. Bhabha. *Indian Acad. Sci., Proc. Sect. A*, **10**, *pp.* 324–332, *Nov.*, 1939.—It is shown that when a point charge is present in an electromagnetic field, the conservation of energy and momentum does not in general lead to conservation of angular momentum for the system as a whole. The conservation laws impose stringent restrictions on the possible equations which may describe the motion of the point charge. If it is required that higher derivatives of the velocity than the second should not appear explicitly in these equations, then the choice is unique and the only possible equations are those originally derived by Lorentz. If the third derivative is allowed to appear explicity in the equations, but not higher ones, then it is possible to give one other system of equations for describing the behaviour of a point singularity which can be used without entirely artificial initial and final conditions. Author.

538. Atomic constants. F. Kirchner. *Ergeb. d. exakt. Naturwiss*, **18**, *pp.* 26–77, 1939.—A critical review of the methods and results of measurements of e, m and h. The subject matter is divided into 5 main sections: (1) Determination of e; (2) Determination of e/m for free electrons and by spectroscopic methods; (3) Determination of h/e; (4) Other combinations of h, m and e; (5) Relations between the atomic constants and their combinations. A list of 104 references to original papers is given. J. E. K.

539. Proton and electron masses. A. Eddington. *Roy. Soc., Proc. A*, **174**, *pp.* 16–41, *Jan.* 12, 1940.—A new derivation by relativistic wave mechanical methods is given of the quadratic $10\,m^2 - 136\,mm_0 + m_0^2 = 0$, the solutions of which are the masses of the proton and the electron. It is claimed that the method of solution gives more physical insight into the nature of the problem. The point of entry to wave mechanics is through the density of a fully occupied wave function. One extrinsic standard, mass, is adopted throughout. The theory of the natural normalization volume is developed for non-degenerate wave functions and then the subject of degeneracy is discussed. A system of object and comparison particles is used. The basis of the calculations is that degenerate particles can be treated as simple particles provided that their contributions to the energy tensor are multiplied by the degeneracy factor as if it were a weight factor. By equating the sum of the energy tensors of the object particles and comparison particles to that of the bi-particles a relation is obtained which is easily reduced to the required quadratic. It is shown by a new method how the degeneracy factors of the wave tensors involved are connected with the mechanical characteristics of the particles. [See following Abstract.] G. O. B.

540. Neutron and mesotron masses. A. Eddington. *Roy. Soc., Proc. A.*, **174**, *pp.* 41–49, *Jan.* 12, 1940.—Using the theory developed [see preceding Abstract], the author calculates the mass of the neutron by assuming that a neutron is produced from a proton and an electron on the emission of a neutrino. The emission of the neutrino is taken to imply that one of the particles, internal or external, to which the proton and electron are equivalent, loses its spin. The result found is that the mass of the neutron exceeds that of the H atom by very nearly 1·5 electron masses. In the case of the mesotron it is necessary to express the fact that an electron, by combining with a neutrino, becomes a mesotron. The mesotron is considered as a pseudo-discrete double vector with a degree of degeneracy 60, which is converted into a pseudo-discrete double vector of full degeneracy 136. This leads to a value of the mesotron mass of 173·17 current electron masses. The theory given here is shown to lead to a better understanding of nuclear structure; and in particular it demonstrates that mesotrons have no connection with Yukawa particles, which latter are identical with the comparison particles of this theory. G. O. B.

541. Polarization of electrons. K. Kikuchi. *Phys. Math. Soc. Japan, Proc.*, **21,** *pp.* 524–527, *Sept.*, 1939.—In investigating the polarization of electrons, the intensities of electrons scattered twice at approximately 90° from gold foils have been measured at azimuthal angles of 0° and 180°. Magnetic analysis of the scattered beams has been employed. The author claims that the results agree closely with the theoretical values predicted by Mott. G. O. B.

542. Mesotron absorption. H. Yukawa and T. Okayama. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 934, *pp.* 385–389, *Oct.*, 1939.—A theoretical discussion of the loss of energy experienced by slow mesotrons in passing through matter. Four factors are indicated as being chiefly responsible for the loss and one of these—absorption by a nucleus—is considered in detail. A. H.

543. Scattering of photoneutrons. T. Goloborodko and A. Leipunski. *Phys. Rev.*, **56,** *pp.* 891–892, *Nov.* 1, 1939.—This preliminary note gives experimental results obtained for the cross-sections for the scattering of photoneutrons from D by the nuclei of light elements from H to Ca. Agreement between results for RaTh + D and Ra + Be [see Abstract 3806 (1937)] is satisfactory except in the case of Mg and Si. E. E. W.

544. Proton-proton scattering. E. Creutz. *Phys Rev.*, **56,** *pp.* 893–894, *Nov.* 1, 1939.—The analysis of Breit, Thaxton and Eisenbud [see Abstract 3012 (1939)] is extended to include every 50 kV and every 2½° from 15° to 45°, and experimental results fitted to the data thus obtained. Curves are plotted and the deviations between experiment and theory discussed. E. E. W.

545. Scattering of protons by protons. Part III. N. P. Heydenburg, L. R. Hafstad, and M. A. Tuve. *Phys. Rev.*, **56,** *pp.* 1078–1091, *Dec.* 1, **1939.**—Previous measurements on anomalous proton-proton scattering [see Abstract 1311 (1938)] in the energy region 600–900 kV were repeated with new and improved scattering apparatus. The scattering of protons by spectroscopically pure A was found to obey the Rutherford-Darwin formula, and served as a calibration of the voltage scale in absolute units. The scattering anomaly arises from the failure of the Coulomb law of repulsion for very close distances of approach, because of a strong short-range nuclear attraction between two protons. The newer measurements are in good agreement with former results which corresponded in wave mechanics to a simple *s* wave scattering. There is no clear evidence in the newer data for higher-order scattering, although the Mott ratios for angles from 20° to 30° are higher by 5 to 10% than would be predicted

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from the values for 40° to 45° on the basis of *s* wave scattering only. These observed systematic deviations are of the type which would be contributed by a small amount of *p* wave scattering superposed on the spherically symmetrical *s* wave scattering. N. M. B.

546. Deuteron-deuteron, proton-helium, and deuteron-helium scattering. N. P. HEYDENBURG AND R. B. ROBERTS. *Phys. Rev.*, **56,** *pp.* 1092–1095, *Dec.* 1, 1939.—Measurements have been made on deuteron-deuteron scattering at angles between 20° and 45° for incident deuteron energies of 832, 720, and 614 kV. In this range of angles and energies the ratio of the observed scattering to that predicted by classical theory, as modified according to Mott to take account of the identity of the particles, is always greater than unity. At 832 kV the ratio increases from 1·28 at 15° to 3·98 at 45°. This anomaly is of the type to be expected if there is present a short range repulsive force between the particles in addition to the Coulomb force. The scattering of protons in helium was in agreement with the Rutherford-Darwin scattering formula for 994-kV protons in the angular range from 20° to 45°. The scattering of deuterons in helium showed an anomaly which increased from about unity at 20° to 4·4 at 75°. This anomaly also indicates an additional repulsive nuclear force between the deuteron and helium particles. AUTHORS.

547. Phase-shift calculations for proton-proton scattering at high energies. H. M. THAXTON AND L. E. HOISINGTON. *Phys. Rev.*, **56,** *pp.* 1194–1198, *Dec.* 15, 1939.—The theoretical *s* wave shift for the square well and the Gauss error well which is fitted to experiment from 0·7 to 2·6 eMV. is calculated up to energies of 10 eMV. Coulomb functions needed for this purpose are tabulated and the phase-shift, as well as the ratio of theoretical scattering to that expected according to Mott's formula, is represented graphically as a function of the energy. The Gauss error well and the square well are found to give very similar extrapolations of the experimental phase-shifts to high energies. AUTHOR.

548. Scattering of mesotrons in metal plates. J. G. WILSON. *Roy. Soc., Proc., A*, **174,** *pp.* 73–85, *Jan.* 12, 1940.—An extended series of accurate measurements of the scattering of mesotrons is described. These are in general agreement with earlier measurements [see Abstract 3996 (1939)], and confirm within the accuracy of the experiment (about 4%) the theoretical value given by Williams for multiple Coulomb scattering [see Abstract 1617 (1939)]. Theory shows that the scattering by a finite nucleus should be about 10% less than that by a point nucleus. The experimental results, which have an accuracy of about 4%, definitely confirm the lower value and so can be considered as supporting the correctness of the scattering theory as applied to a finite nucleus. The evidence for the existence of large-angle scattering due to short-range forces between mesotrons and nuclear heavy particles (protons and neutrons) is discussed. The cross-section for this type of scattering is estimated to be of the order 10^{-28} cm^2., and this value is in agreement with that given by Bhabha for a " classical " mesotron theory. There is no experimental evidence for the large increase of scattering due to short-range forces at low mesotron energies given in the quantum mechanical treatment due to Heitler. For the available mesotrons of lowest energy, the cross-section is found to be less than 10^{-27} cm^2. This result is not compatible with the present development of mesotron theory, and may be interpreted as indicating a failure in the treatment of the charge-exchange which leads to the interaction between charged mesotrons and heavy particles. AUTHOR.

549. Azimuthal dependence of processes involving mesons. T. S. Chang. *Cambridge Phil. Soc., Proc.*, **36**, *pp.* 34–42, *Jan.*, 1940.—The elastic scattering of Yukawa particles, or mesons, by a static electric field is recalculated by considering the scattering as a process in which the incident meson is absorbed and another meson, i.e. the scattered meson, is created, and Laporte's result [see Abstract 428 (1939)] is confirmed. This method promises an easier handling of the second approximation. A similar dependence of the angular distribution of the emitted quanta upon the spin of the incident mesons in a process like $Y^- + P \rightarrow N + h\nu$ is found. Thus, the angular distribution contains a dependence upon the azimuthal angle in general for the reverse process, the angular distribution of the emitted mesons, both longitudinal and transverse, contains also a dependence upon the aximuthal angle, which disappears only when the incident light is circularly polarized. Author.

550. Absorption of high energy electrons. Part IV. M. M. Slawsky and H. R. Crane. *Phys. Rev.*, **56**, *pp.* 1203–1210, *Dec.* 15, 1939.—The scattering of electrons in Pb and in Al has been studied, mainly under the conditions used previously for the study of energy loss. The primary object of the investigation was to determine the extent to which the existing energy loss data (up to 13·5 eMV) are affected by multiple scattering. The conclusion reached is that the measurements so far made in Pb with electrons below 9 eMV are so much affected by multiple scattering within the absorbing material that they are of very little use as a direct check on the theory for energy loss. In the measurements from 9 to 13·5 eMV the scattering is found to be small enough for a comparison of the energy losses with the theoretical values to be possible. The observed losses are roughly 40% in excess of the theoretical. Some measurements on the multiple scattering of 0·9-eMV electrons in thin sheets of Al were made, and it was found that the most probable angle of scattering and the average angle of scattering were in good agreement with theoretical predictions. [For Part III see Abstract 2156 (1938).] Authors.

See also Abstracts 365, 429, and
57B. Diffraction of electrons. J. Loiseau.

ELECTROSTATICS.

551. Problem of electrostatics. L. Sobrero. *Accad. d' Italia, Mem.*, **10**, 5, *pp.* 143–157, 1939.—The solution of the problem of two conducting spheres of different radius, and at different potentials, is derived by a new method. R. P.

552. Electric field produced by a point-charge located outside a dielectric wedge. S. O. Rice. *Phil. Mag.*, **29**, *pp.* 36–46, *Jan.*, 1940.—The electric field produced by a point-charge lying between two plane conductors which intersect at an angle π/n, where n is any positive integer, may be solved by the method of images, but when the angle is not of the form π/n the problem becomes more complicated, and a similar problem is now considered. Instead of considering the two intersecting planes to be conductors, the author assumes that they are the two bounding faces of an infinite dielectric of dielectric constant $\epsilon > 1$ but finite, that the point-charge is outside the dielectric, and that it does not touch the boundaries of the wedge. When ϵ is set equal to unity and infinity in the series derived for the potential, the known results will be obtained. The potential produced by the point charge q at the point $(\rho_0, \theta_0, 0)$ is $V_a = V_0 + \frac{iq}{\pi\sqrt{\rho\rho_0}} P \int_{-i\infty}^{+i\infty} Q_{\lambda-\frac{1}{2}}(s)\, f(\lambda, \theta)\, d\lambda$, outside the wedge ("$a$" signifying "air") and $V_w = \frac{iq}{\pi\sqrt{\rho\rho_0}} P \int_{-i\infty}^{+i\infty} Q_{\lambda-\frac{1}{2}}(s)\, g(\lambda, \phi) d\lambda$ in the wedge. P signifies that Cauchy's principal value is to be taken and $Q_{\lambda+\frac{1}{2}}(s)$ denotes the Legendre function of the second kind. The conditions to be satisfied by V_a and V_w are stated, the integrals for V_a–V_0 and V_w are derived together with series for the potentials, and the two-dimensional case is considered at length. H. H. Ho.

553. Frictional electricity from polar solutions. G. Lovera and A. Pochettino. *N. Cimento*, **16**, *pp*. 337–347, *July*, 1939.—An extension of previous work by the same authors [see Abstract 1317 (1938)]. A mist of liquid suspended in an atmosphere of N_2 at 50 mm. Hg is circulated so that it passes between plates connected to an electrometer. The frictional charge is measured by the rate of increase of voltage. The liquids used were dioxane, benzene, xylene and toluene, and solutions in them of hydrocarbons of appreciable dipole moment. Tables and curves of results are given in detail. The charges were found to depend on the dipole moment. In every case an increase of dipole moment caused an increase of charge. Positive and negative charges were unequal, and the ratio (positive charge)/(negative charge) was inversely proportional to the dipole moment. Lenard's hypothesis of frictional charges arising from a double layer is held to be disproved, for the present liquids. Instead it is suggested that the liquids have superficially a crystalline structure, and that frictional charges are generated when the crystals are fractured. W. H. W.

See also Abstract 339.

GALVANOMAGNETIC AND THERMOMAGNETIC EFFECTS.

See Abstract 578.

MAGNETISM AND ELECTROMAGNETISM.

554. Dependence of ferromagnetic anisotropy on field strength. L. P. Tarasov. *Phys. Rev.*, **56**, *pp*. 1224–1230, *Dec*. 15, 1939.—In evaluating the anisotropy constants of ferromagnetic materials a common method is to measure the torque exerted on a specimen of circular section by a uniform magnetic field, to determine the maximum torque by extrapolation to infinite field strength, and to multiply this by an appropriate number. The law of approach of the torque, T_H, to its limiting value, T_∞, is now found to be $T_H = T_\infty (1 - H_0/H_a)$ for a number of discs and ellipsoids of single crystals of Fe-Si alloys containing up to 7·4% Si, and for polycrystalline discs of Fe and of Si steel. Here H_a is the strength of the applied field uncorrected for demagnetizing field and H_0 is a constant which depends mostly upon the dimension-ratio of the disc. This law is discussed in relation to a similar law proposed by Schlechtweg, and to the familiar law of approach of magnetization to saturation. It is concluded that for discs the approach to saturation of the torque peaks is connected with the lack of magnetic saturation at their edges. [See following Abstract.] Author.

555. Ferromagnetic anisotropy of Fe and Fe-rich Si alloys. L. P. Tarasov. *Phys. Rev.*, **56**, *pp*. 1231–1240, *Dec*. 15, 1939.—The ferromagnetic anisotropy constant K_1 has been accurately measured by the magnetic torque method for a group of Fe alloys containing up to 13·7 atomic % Si. The points fall on two intersecting straight lines given by the equations: $K_1 \times 10^{-5} = 5{\cdot}29 - 0{\cdot}279\,A$, $A < 9{\cdot}86$; and $K_1 \times 10^{-5} = 4{\cdot}43 - 0{\cdot}191\,5\,A$, $A > 9{\cdot}86$. K_1 is expressed in ergs/cm³. and A is the atomic percentage of Si. The value for Fe is considerably higher than the one due to Akulov which has often been quoted in the literature. It is shown that the latter is unreliable because it is an average value based on the highly discordant results of several investigators. Torque measurements were made on the identical ellipsoid of Fe for which Piety measured the magnetization curves along the simple crystallographic directions and a large discrepancy was found between the values of K_1 calculated by these two methods. This leads to the belief that the present-day theory of ferromagnetic anisotropy is in need of some revision, possibly in connection with the higher order terms in the magnetic energy equation. When K_1 is plotted against the atomic percentage of Si, the change in slope occurs at very nearly the same concentrations as the similar change in slope found by Jette and Greiner for the lattice parameter a_0. An attempt is made to explain the occurrence of these breaks in terms of a change from a hypothetical superlattice with a Si concentration of 3/32 to a partially formed Fe_3Si superlattice. [See preceding Abstract.] AUTHOR.

556. Magnetic susceptibility of $NiCl_2$. H. R. NETTLETON AND S. SUGDEN. *Roy. Soc., Proc. A*, **173,** *pp.* 313–323, *Dec.* 18, 1939.—The susceptibility of $NiCl_2$ in solution was measured with high accuracy by the Gouy method and found to be $4\,436 \pm 12 \times 10^{-6}$ per gm.mol. at 20°C. Since $NiCl_2$ is known to have a susceptibility independent of concentration in solution, it can serve as a convenient standard of reference. D. S.

557. Crystal diamagnetism of Te. S. R. RAO and S. R. GOVINDARAJAN. *Indian Acad. Sci., Proc. Sect. A*, **10,** *pp.* 235–252, *Oct.*, 1939.—The diamagnetic susceptibilities of single crystals of Te and of Te alloys with up to 1 atomic % Pb, Sn, Bi and Cd were measured by the Gouy method at 30°C., and also, in the case of the pure Te, at temperatures up to 500°C. (beyond the melting point). Pure Te was slightly anisotropic ($\Delta K/K \sim 0{\cdot}1$ at 30°C.) and the anisotropy decreased with increase of temperature, becoming negligible at about 200°C., although the mean susceptibility did not vary much with temperature. Both the anisotropy and the mean susceptibility were decreased in all cases by alloying. D. S.

558. Magnetic susceptibility of metahaemoglobin. P. BERTHIER. *Comptes Rendus*, **209,** *pp.* 774–776, *Nov.* 20, 1939.—The substance was prepared at a low temperature by dehydration of oxyhaemoglobin, kept below 0°C. until used, then tested at a temperature below 11°C. in aqueous solution, also in presence of HCl and of NaOH. The solution in water has a constant paramagnetic susceptibility; with HCl the susceptibility is also paramagnetic and increases with time, but NaOH solutions are diamagnetic and the susceptibility also increases with time, becoming positive for the weaker concentrations of NaOH. The susceptibility of fresh solutions of metahaemoglobin varies from $k \times 10^6 = +0{\cdot}46$ to $-0{\cdot}21$ as the pH values vary from 1·1 to 14·0. The aqueous solution has $k = +0{\cdot}15 \times 10^{-6}$ for pH 7·2. [See also Abstract 3028 (1939).] G. E. A.

559. Paramagnetic susceptibility of Cu-Ni and Zn-Ni alloys. M. A. WHEELER. *Phys. Rev.*, **56,** *pp.* 1137–1145, *Dec.* 1, 1939.—Alloys of Ni were prepared with 0 to 60% Cu or 0 to 30% Zn. Their susceptibilities above their Curie temperatures were measured as a function of the temperatures using a Weiss-Foëx magnetic balance at a field of 11 000. Plots of $1/\chi$ against T showed that the Curie-Weiss law holds only in restricted ranges of temperature, the curve becoming concave towards the T axis at high temperatures, especially for the alloys of low Ni content. The susceptibility at a given temperature decreases less rapidly than linearly with % Cu or Zn added. These results are discussed from the points of view of the Heisenberg and the Bloch models. AUTHOR.

560. Paramagnetic dispersion in iron ammonium alum. P. TEUNISSEN AND C. J. GORTER. *Physica*, **6,** *pp.* 1113–1122, *Dec.*, 1939. *In English.*—The observations [see Abstract 847 (1939)] on the paramagnetic dispersion of iron ammonium alum are extended to higher frequencies. The results as a whole are in good agreement with the formula obtained from the conception of a spin temperature. The search for an anisotropy of dispersion in a crystal led to a negative result. The two conclusions suggest that the idea of a spin temperature can be utilized in the case of very strong magnetic fields. Finally, there is discussed the dependence of the constants of relaxation on temperature, in which it is shown that the description of the heat motion of the crystal lattice as due to one characteristic temperature is too simple to explain the details of the measurements. G. E. A.

561. Paramagnetic hysteresis. H. N. V. TEMPERLEY. *Cambridge Phil. Soc., Proc.*, **36,** *pp.* 79–83, *Jan.*, 1940.—Ewing's original theory of hysteresis, though not admissible for metals, seems to apply to paramagnetic salts. The peculiar form of the interaction between dipoles implies that a certain fraction of them may be incapable of following small changes in the external field. The agreement with experiment is satisfactory considering the rough nature of the theory. AUTHOR.

562. Gyromagnetic effect in Mn-Sb and Fe-Se alloys. F. GALAVICS. *Helv. Phys. Acta*, **12,** 7, *pp.* 581–608, 1939. *In German.*—Using the resonance method of Coeterier and Scherrer [see Abstracts 4610 (1932) and 5235 (1935)], the gyromagnetic effect was measured in an Mn-Sb alloy (50% by weight) and an Fe-Se alloy, both of which are ferromagnetic. For the former alloy the g-factor was found to be approximately 2, while for the latter, values less than 1 were found, confirming its similarity to pyrrhotine for which $g = 0 \cdot 63$. The accuracy in the latter case, however, was not high, owing to an appreciable remanence. A detailed discussion is given of the experimental technique. D. S.

***563. Design of powerful electromagnets. Part IV.** F. BITTER. *Rev. Sci. Instruments*, **10,** *pp.* 373–381, *Dec.*, 1939.—This paper deals with the details of design and operation of air-core water-cooled coils dissipating up to 1 700 kW. Four magnets have been built and used. The first is intended primarily for the measurement of the magnetization of any substance at any temperature in fields up to 40 000 gauss. The second was designed to test the desirability of a new type of construction. The third gives fields up to 100 000 gauss uniform within 1% in a volume of 25 cm^3., and is to be used primarily for Zeeman effect and other optical experiments. The fourth can produce fields up to 50 000 gauss uniform within 1% in a volume of almost 1 l., and is designed primarily for experiments at very low temperatures. The power to operate these magnets is supplied by a motor generator capable of giving 10 000 A at 170 V continuously. [For Part III see Abstract 4716 (1937).] AUTHOR.

See also Abstracts 323, 426, 506, 537, and
65B. Magnetic flux meter. G. S. Smith.

MEDICAL RADIOLOGY AND ELECTROLOGY.

564. Comparison of electrical and diffusion forces in metabolism of electrolytes. R. R. WILLIAMSON. *Math. Biophysics, Bull.*, **1**, *pp.* 151–157, *Dec.*, 1939.—Using an approximation method the electrical forces due to the metabolism of electrolytes have been compared with the ordinary diffusion forces and found negligible. AUTHOR.

***565. Serioscopy.** G. B. BUSH. *Brit. J. of Radiology*, **12**, *pp.* 611–618, *Nov.*, 1939.—Serioscopy is a radiographic method derived from planigraphy [see Abstract 4705 (1938)]. It consists in building up an infinity of sectional views by means of several films taken in several specified positions selected from the planigraphic trajectory of the X-ray tube. In planigraphy the film is moving in such a way that all the elements in the selected plane stay apparently immobile, and give a sharp image. In serioscopy, the film is immobile, while the image of the elements in any one plane is displaced. If one now superimposes all the films, it is easy, by a judicious sliding of all the films over each other to cause all the elements common to each plane to coincide successively, starting with the plane nearest the film and ending with that plane which is farthest from it. The apparatus consists of illuminating boxes fitted with high-pressure Hg lamps and a mechanism for the purpose of sliding one film upon the other. In taking the films the tube shift is arranged, e.g. for lungs and parts of the body 20–30 cm. thick, to be 10% of the anode film distance, say 15 cm. shift from each side of the centre point at 150 cm. distance. For the skull, limbs, etc., whose thickness is less than 20 cm. a shift of 15%, say 12 cm. at 80 cm. distance (4·5″ at 30″ focal distance). In the special case of pulmonary serioscopy it is essential that the four pictures be made in the same phase of respiration and for this purpose a special respiratory switch has been devised which " fires off " the X-ray generator at a predetermined moment. It consists of a belt containing an inflated rubber bag connected by rubber tubing to a mercury manometer. A copper plunger in the manometer is adjusted so that the relay circuit can be completed by the contact and switch on the X-ray apparatus and a series of exposures made by the patient himself at the same phase of respiration and at a time selected by the operator who controls the main switch. A complete description is given of the mechanical accessories necessary for the taking of " seriographs " and the clinical applications. T. A. C.

OSCILLATIONS AND WAVES.

***566. Theory of klystron oscillations.** D. L. WEBSTER. *J. of Applied Physics*, **10**, *pp.* 864–872, *Dec.*, 1939.—The principles governing the oscillations in a klystron may be divided into four groups: (1) those of space resonance within each rhumbatron, previously discussed by Hansen; (2) the equations of coupled circuits, with modifications appropriate to space-resonant systems; (3) the kinematics and dynamics of cathode-ray bunching, previously discussed by the author; (4) the constraint on phase relations between the rhumbatrons introduced by the cathode-ray bunches. It is shown here that (4) makes the oscillations assume forms very different from those familiar in free oscillations. These forms are described by general equations and then these equations are applied to three specific problems: maximizing the power output from an oscillator, minimizing the power input for an ideal regenerative amplifier, and finding how stable the frequency is against changes in cathode potential [See Abstract 3463 (1939).] AUTHOR.

567. Effect of space-charge in the magnetron. E. B. MOULLIN. *Cambridge Phil. Soc., Proc.*, **36**, *pp.* 94–100, *Jan.*, 1940.—The persistence of a small anode current in a diode for values of the magnetic field much greater than the theoretical critical value is due partly to imperfections of mechanical construction, but the mechanism of the effect is largely unexplained. A discussion is given of this effect, treating first the planar magnetron with zero field at the cathode and then the magnetron with cylindrical electrodes. It does not appear that the presence of space-charge can do anything to increase the chance of an electron reaching the anode when the magnetic field H exceeds the critical value. Indeed it would seem to decrease this possibility, since it causes the boundary of the cloud to withdraw further from the anode. It is clear that, in practice, a potential barrier will not exist when H is several times the critical value, and then it would appear that the effect of space-charge becomes progressively more negligible. It would be most helpful if the electron paths could be solved for an eccentric system of electrodes. If such a solution showed that a spiral path existed and that such a path was likely even when the eccentricity was very small, we should know that the practical impossibility of complete cut-off is due to imperfections of mechanical construction. Electronic oscillations offer another possible explanation. A. W.

568. Rectification in discharge tubes. V. T. CHIPLONKAR. *Indian Acad. Sci., Proc. Sect. A*, **10**, *pp.* 381–387, *Nov.*, 1939.—The rectification in discharge tubes has been quantitatively measured for two ranges of pressures varying from 500 to 20×10^{-4} cm. Hg. and 0 to 1·8 cm. in the case of the gases air (i.e. a mixture of O_2 and N_2), O_2 and N_2 in differently designed discharge tubes. Rectification is found to be present in all cases under all conditions, except in one, although the direction and magnitude of rectification varies within wide limits. AUTHOR.

569. Wave reflections from diffuse boundaries. C. D. THOMAS AND R. C. COLWELL. *Phys. Rev.*, **56**, *pp.* 1214–1216, *Dec.* 15, 1939.—The intensity of the waves reflected from various types of diffuse boundaries in which the dielectric constant changes only slightly is considered. The constant inside the reflection layer is assumed to vary as some power of the distance. It is further assumed that above and below this transition layer the media are uniform. The calculations show that the rate of decrease of intensity of the reflected wave with increasing layer thickness is more rapid for large values of μ the index of refraction, than for values close to unity. Fresnel's equations are therefore applicable to layers of considerable thickness if μ is very close to unity. AUTHORS.

570. Critical frequencies in ionosphere observed at Rome from Dec. 1938 to Sept. 1939. I. RANZI. *Ricerca Scientifica*, **10**, *pp.* 926–929, *Oct.*, 1939.—This paper is a continuation of previous work [see Abstracts 1846 and 3823 (1939)] on the determination of critical frequencies. By extending the range from 5·5 to 10 Mc./s. it has become possible to investigate the F_2-region also. The measurements were carried out in Rome, during the months Dec. 1938 to Sept. 1939, and curves are given for each of these months. The existence of a longitudinal effect in the F_2-region seems to be confirmed; the critical frequency observed at Rome is mark-

edly higher than that observed at Washington, e.g. in July, Rome 8·95 Mc./s.; Washington 7·6 Mc./s. with corresponding electronic densities of Rome $6\cdot1 \times 10^5$ and Washington $8\cdot74 \times 10^5$ electrons per cm. Data concerning ionospheric tempests are also recorded and given in tabular form. Various sporadic E-layer reflections were observed and recorded.
G. G.

571. Height of reflection of radio waves at Rome from Jan. 1939 to Sept. 1939. A. BOLLE. *Ricerca Scientifica*, **10**, *pp.* 930–932, *Oct.*, 1939.—This paper records measurements on the height of reflection of radio waves of 6 Mc./s. frequency from the F_2-layer. The measurements extend from the 1st Jan. 1939 to the 30th Sept., and were made in Rome with apparatus previously described [*ibid.* 9. *pp.* 5–6, *March*, 1938]. Reasons for the diurnal variation in the height of reflection throughout the year are also discussed. G. G.

572. Wave form, energy and reflection by the ionosphere, of atmospherics. T. H. LABY, J. J. MCNEILL, F. G. NICHOLLS AND A. F. B. NICKSON. *Roy. Soc., Proc. A*, **174**, *pp.* 145–163, *Feb.* 1, 1940.—The wave form of the electromagnetic pulse radiated from a lightning flash, known as an atmospheric, has been studied. The atmospherics are received on a vertical aerial which is connected through an aperiodic amplifier to a cathode-ray tube. The spot on the screen of the tube is photographed on a film fixed to the external surface of a cylindrical drum which rotates at a uniform peripheral speed. Many hundreds of wave forms have been recorded from atmospheric sources 70–1 500 km. distant, and incidental to the observations made by the authors, evidence has been obtained of the reflection of atmospherics at an ionized layer. Such records show the intervals of time elapsing between the arrival of the first pulse along the ground and the various reflected pulses. From the simple theory and methods of reduction given in the paper, it is possible to determine the height of the reflecting ionized layer and the distance of the flash. When this is done, the height of the layer is found to be between 53 and 82 km., values in reasonable agreement with the lower limits of the E-layer. The observations are consistent with the sky wave and the ground wave, having the same velocity to 0·7%. Oscillograms of typical atmosphere wave forms are shown, together with a possible interpretation of many of them. The assumption is made that the electrical discharge which radiates an atmospheric is a damped oscillation with a period determined by the instantaneous resistance, inductance and capacity. The relation between the distance of an atmospheric source and its field strength is found to be linear and figures are given for the peak power and the total energy radiated as found from representative examples. AUTHORS.

See also Abstracts 340, 426, and

162B. The solar cycle and the F_2-region of the ionosphere. W. M. Goodall.

PHOTO-ELECTRICITY.

573. Photo-electric effect in incandescent W. V. RICCA AND M. DELLA CORTE. *Accad. Lincei, Atti*, **29**, *pp.* 685–691, *June* 17, 1939.—The authors have investigated the existence of a photo-electric effect when incandescent W at a temperature of 2 400°K. is irradiated. In conformity with what would be expected on Fowler's theory, they find that radiation of wavelength greater than 360 mμ produces a detectable effect. J. W. T.W.

574. Changes in internal resistance of Se barrier-layer cells caused by exposure to light. A. E. SANDSTRÖM. *Phil. Mag.*, **28**, *pp.* 642–648, *Dec.*, 1939.—If Se barrier-layer cells are exposed to light, or to X-rays, for several hours, their resistance is decreased. The decrease is of the order of some 20% and, within the range of the observations, the percentage decrease is the same for all voltages. When the light source is removed the original value of the resistance is restored in about 10 min. The effect is studied for various cells and with different types of light source. R. P.

575. Limiting sensitivity of a.c. method of photocell current amplification. E. A. JOHNSON, W. H. MOCK AND R. E. HOPKINS. *J.O.S.A.*, **29**, *pp.* 506–511, *Dec.*, 1939.—The limiting sensitivity of an a.c. system of amplification is considered. The practical limit is determined theoretically and experimentally for measured circuit parameters. A particular circuit using an electrometer-tube and a Cs-Sb cell is shown to be capable of detecting $4 \cdot 5 \times 10^{-15}$ W in 30 sec. Data on various input-tubes and photocells are given. AUTHORS.

See also Abstract 419.

PIEZO-ELECTRICITY.

See Abstracts 338, 528.

THERMIONICS.

576. Oxide-coated cathodes. Part II. J. P. BLEWETT. *J. of Applied Physics*, **10**, *pp*, 831–848, *Dec.*, 1939.—A comprehensive survey is presented of the properties of oxide-coated cathodes under the following headings: (1) Chemical properties of the alkaline-earth oxides. (2) Physical properties of mixtures of alkaline-earth oxides. (3) Properties of the alkaline-earth metals; thin films on W. (4) Methods for detection of (BaSrCa). (5) Preparation of oxide-coated cathodes. (6) The activation process. (*a*) Liberation of alkaline-earth metal. (*b*) Activation due to free alkaline-earth metal. (*c*) Mechanism of reduction of oxide. (*d*) Origin of emitted electrons; distribution of free (BaSrCa). (7) Electrical properties of oxide-coated cathodes. (*a*) Emission constants. (*b*) Anode voltage effect. (*c*) Electron temperature. (*d*) Shot effect. (*e*) Photoelectric effect and secondary emission. (*f*) Time effects. (*g*) Influence of gases on electron emission. (*h*) Influence of positive ion bombardment on electron emission. (*i*) Surface distribution of emission. (*j*) Effect of particle size on emission and (*k*) Decay of emission. A full Bibliography of about 120 references is appended. [For Part I see Abstract 285 (1940).] A. W.

577. Differential method applied to the surface ionization of sodium halides on tungsten. A. A. JOHNSON AND T. E. PHIPPS. *J. Chem. Phys.*, **7**, *pp.* 1039–1046, *Nov.*, 1939.—A differential molecular-beam method for the study of the surface ionization of salts was developed. A reference filament and a working filament were placed in the paths of molecular beams emitted from the same furnace orifice; and the ratios of the positive-ion currents collected from the two surfaces were measured with a centre-tap galvanometer for different temperatures of the working filament. This method was applied to the study of the ionization of sodium halides on W and W-O surfaces. The results were not in close agreement with the simple theory of the ionization of a gaseous Na atom at a W surface. The energy quantity, $(I - \Phi)\epsilon$, (I being the ionization potential of the alkali atom, and Φ, the work function of the surface) was about 0·3 eV less than that demanded by theory. To explain this defect an extension was made of the simple theory, in which it was assumed that a small fraction of the surface was covered with halogen atoms even to high temperatures. The experimental results could then be explained upon the assumption that from 2 to 4% of the W surface (the exact value depending upon the particular halide and W surface involved) held adsorbed halogen atoms up to 2 600° K. AUTHORS.

See also Abstract 340.

THERMO-ELECTRICITY.

578. Thermoelectric power of pure beryllium crystal and its variation in a transverse magnetic field, E. GRÜNEISEN AND H. D. ERFLING. *Ann. d. Physik*, **36.** 3–4, *pp.* 357–367, *Oct.*, 1939.—The thermoelectric power of a Be crystal is measured in a transverse magnetic field. Its variation with the magnitude and direction of the field and with the temperature is determined. Many curves are given to illustrate the results. Fields up to 12,000 oersteds are used and temperatures down to −250° C. With no magnetic field the thermoelectric power for $\mathrm{Be}_{\parallel}$–$\mathrm{Be}_{\perp}$ rises rapidly with the temperature to a value of about 14 at room temperature. W. E. D.

See also Abstract 522.